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JANUARY/FEBRUARY 2016

SkyNews

The Canadian Magazine of Astronomy & Stargazing

TOP 10 SKY SIGHTS FOR 2016

Comet Catalina Near Big Dipper in January
Pluto and Charon in High Resolution

A Canadian Astronomy Star in the U.S.
Saskatchewan's Newest Dark Sky Park
Probing the Secrets of Black Holes
Beautiful Lunar Eclipse Gallery

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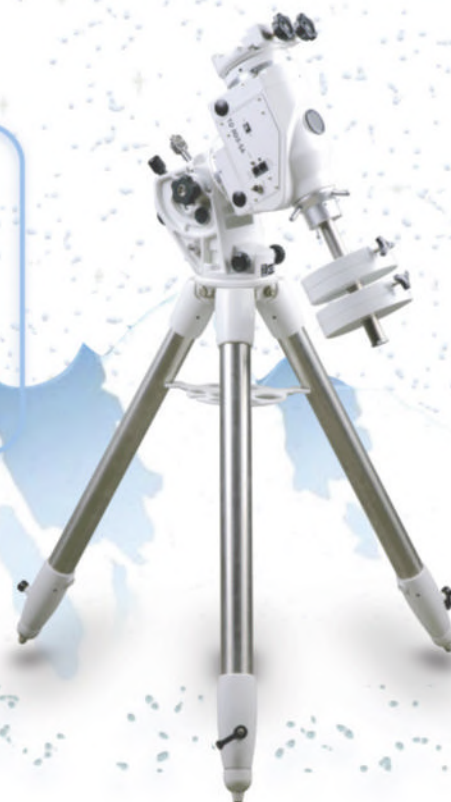
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COVER: Hubble Space Telescope image shows Messier 96, a spiral galaxy about 35 million light-years away in the constellation Leo. M96 is about the same mass and size as our Milky Way Galaxy. COURTESY NASA/ESA



A NEW PARTNERSHIP

The Royal Astronomical Society of Canada recently purchased SkyNews magazine. For our readership, it means the continuing evolution of the only English-language science magazine in Canada.

RASC PRESIDENT'S MESSAGE

THE ACQUISITION OF SKYNEWS by The Royal Astronomical Society of Canada is an amazing development. We on the RASC Board of Directors enthusiastically jumped at the opportunity to expand our publishing efforts to include this well-known and valuable magazine. We thought it was a perfect fit. Because of this purchase, our long relationship with the SkyNews team endures, which can only bode well for our future. We are extremely pleased that most of the team, including Terence Dickinson, will continue to play a part in the production of the magazine.

I am pleased to report that the RASC Executive Director, Randy Attwood, has been appointed Publisher and Chair of a new SkyNews Board of Directors. He has appointed to the Board Colleen Moloney (one of the previous owners), longtime contributor Gary Seronik, RASC executive member Colin Haig and the RASC Office Administrator, Renata Koziol. We have every confidence that the transition from the previous owners to this new RASC venture will proceed in a smooth and orderly manner.

We foresee new synergies developing from our acquisition of SkyNews, new ways to reach out to our members, new ways to conduct education and public outreach and new opportunities for growth.

James Edgar
RASC President

PUBLISHER'S NOTE

ACQUIRING SKYNEWS is a logical step for the RASC: For years, many of the contributors to SkyNews have been RASC members. We are already looking at new ways to promote SkyNews to more Canadians, especially in schools and at public RASC events.

Over the past few months, I have become familiar with how the SkyNews team works and am impressed with how well the team works together. Terence Dickinson, his editors and his contributors continue to produce high-quality articles. Readers continue to submit stunning astrophotos. Janice McLean and Susan Dickinson, the production team, work together to produce a world-class astronomy magazine. Former Publisher Greg Keilty and Associate Publisher Colleen Moloney have a vast knowledge of the magazine industry in Canada. Their attention to detail has positioned SkyNews well and made it a successful niche magazine, a rarity in this country. Denise Havers continues to provide excellent customer service for our subscribers.

The decision to purchase SkyNews was best summed up by Terry at the General Assembly in Halifax: evolution not extinction. We purchased SkyNews to ensure that it continues for many years to come.

J. Randy Attwood
Publisher, SkyNews



SkyNews

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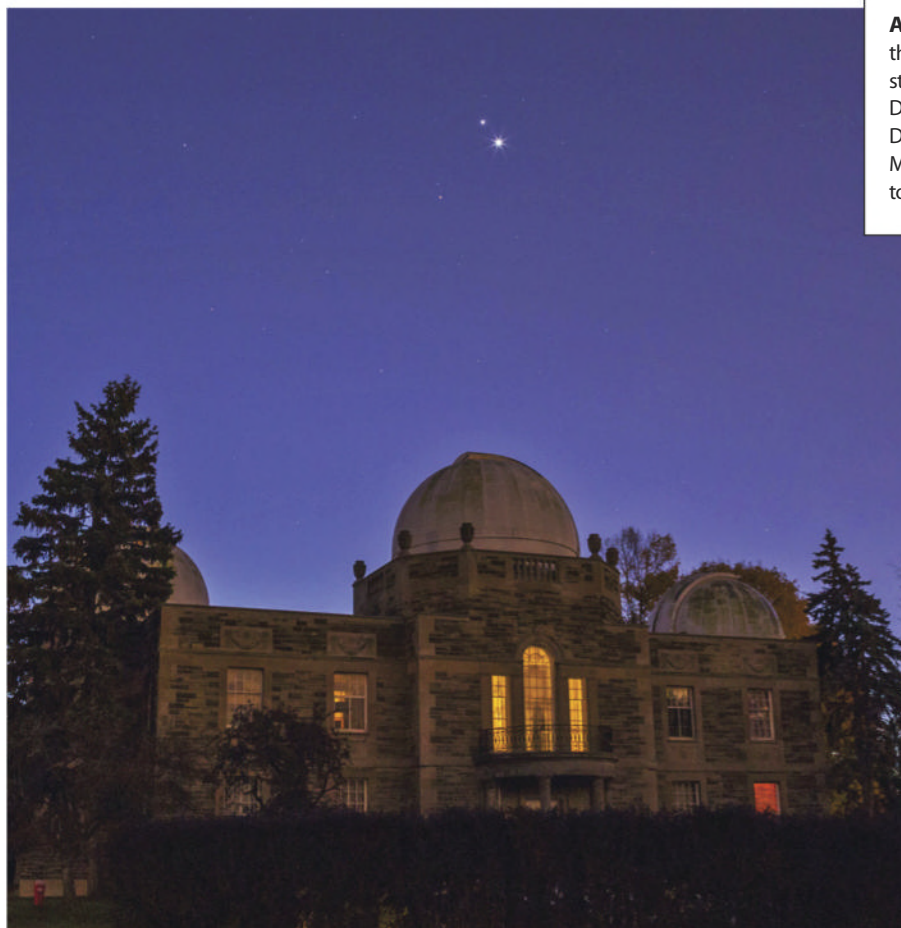
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Planetary Traffic Jam

A sequence of early-morning conjunctions attracted plenty of attention



ABOVE THE DOMES On the morning of October 26, the two brightest planets, Venus and Jupiter, were a striking pair above the administration building of the David Dunlap Observatory, in Richmond Hill, Ontario. Dimmer than the eye-catching pair was another planet, Mars, visible in the eastern morning twilight below and to the left of the brilliant duo. PHOTO BY STUART MCNAIR

I am pleased to report that only one correspondent used the 1950s-era term “UFO” in connection with what was being observed. Virtually everyone sensed that he or she was seeing a natural sky phenomenon but simply did not know what it was. And *SkyNews* was happy to tell them.

Since antiquity, humans have been fascinated by the starry night. In times past, the stargazers among our ancestors realized that the same star patterns are visible around the same time every year. But a few bright “stars”—the planets—had magical properties: They moved among the fixed patterns.

These wandering “stars” were given names relating to their appearance. Venus, the lovely white “star” seen alternately in the morning and the evening sky. Jupiter, the king, because of its steady pale golden glow and its power to roam and dominate the complete ecliptic, the pathway of the planets. And so on.

Further, what were our ancestors to make of a conjunction like the one pictured above? What were Venus and Jupiter and Mars discussing? What did it mean for us mere mortals witnessing the event? It was only natural for humans to wonder what the starry tapestry was telling us—if anything.

Today, the questions are framed by our knowledge of the content and vastness of the cosmos. There is still much to learn in a universe of (roughly) a billion trillion trillion suns.

VERY FEW ASTRONOMICAL EVENTS are so obvious or simply so beautiful that people are compelled to ask, “What *is* that?” The planetary traffic jam in the eastern sky before sunrise last October and early November was just such an event. Venus and Jupiter, the brightest planets in the solar system, along with dimmer Mars were exchanging places and, occasionally, being visited by a crescent Moon. Astronomy enthusiasts were well aware of what was happening (*SkyNews*, Sept./Oct., pages 29-31), but the vast majority of the population had other things on their minds, until looking out an east-facing window, that is, or walking or driving east or southeastward to work, then... “What *is* that?”

By mid-October, the e-mails started arriving at *SkyNews* asking about the bright objects or stars visible around 6 a.m. Some correctly guessed that it was a bright planet or pair of planets, but many had no idea what they were seeing.



FASCINATING SPUTNIK PLANUM One of the most interesting features observed on Pluto by New Horizons is this craterless icy plain, informally named Sputnik Planum. Its lack of craters indicates that it is less than 100 million years old and possibly much younger. The colour of the image is enhanced to aid in feature analysis. For more New Horizons images, see pages 21-23. PHOTO COURTESY NASA

MORE FROM PLUTO

After swinging within one Earth diameter of Pluto and gathering hundreds of images of the remote icy world, NASA's New Horizons spacecraft is heading another billion kilometres outward toward a 45-kilometre-diameter Kuiper belt object known as MU69. It will reach its destination for an image-gathering flyby on January 1, 2019.

In the meantime, for the next six to eight months at least, the 80 percent of the New Horizons' library of images and data still in the spacecraft's memory storage will be transmitted back to NASA's Deep Space Network antennas.

Why is it taking so long?

New Horizons is outfitted with cameras, spectrographs and particle detectors and has the latest (at the time of its launch) data storage and transmission equipment. You might expect that all we would have to do is transmit the data back to Earth at the speed of light. It takes sunlight more than eight minutes to reach Earth, and data from Mars can take as much as 20 minutes, but New Horizons is so distant that it takes more than five hours for data to be transmitted to Earth.

While it's true that data are sent to us from the spacecraft at light-speed, the sig-

nal spreads out over distance, and it requires a Deep Space Network 70-metre-diameter antenna to capture the faint, diffuse signal arriving on Earth from New Horizons, which is five billion kilometres away. And even an antenna that large can collect only 125 bytes of data per second from such a remote source of relatively low power.

For a single image from the onboard camera instrument—roughly a 2.5-megabit image when compressed—it takes 20 to 40 minutes for the 70-metre dish to collect the data. Some high-resolution images take much longer than that. For this reason and because the Deep Space Network antennas have other tasks to handle, the entire library of images stored on New Horizons will not be safely on Earth until late this year.

Editor Terence Dickinson invites your comments about the content of SkyNews and submission of astronomy-related photos. Send to: dickinsonSkyNews@gmail.com.

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Photo credit: Eric Toops (LS152T)



PERFECT ASTRO-MORNING

On the early morning of October 26, the weather was perfectly clear and calm for me to try a superwide panorama of the view from the north side of West Lake, near Wellington in Prince Edward County, Ontario. The conjunction of Venus and Jupiter at left was in the southeast, while Orion was almost in the opposite direction in the west (right). This only mildly distorted view was acquired by digitally stitching together a four-frame panorama that compressed the almost 180-degree view. A Sky-Watcher Star Adventurer tracking mount was used to avoid even slight star trailing, with a Nikon 14-24mm lens at 14mm on a Nikon D810A at ISO 1000. It was a beautiful morning!

*Malcolm Park
Wellington, Ontario*



TAURID AURORA

I checked the possibility of an aurora on the early morning of November 4 and noticed that activity was stepping up a bit compared with earlier in the evening, so I headed out with my camera. I decided to set up on a rural road near home. The waning crescent Moon provided just enough fill light to show the landscape. While shooting the aurora, I was also pleased to capture a Taurid meteor in this photo, seen at lower right. During the hour or so that I was out with the camera, I saw four bright, relatively slow Taurids cross the sky. I used a tripod-mounted Canon 6D at ISO 3200 with a 17-40mm f/4 lens at 17mm for the 20-second exposure.

*Steve Irvine
Georgian Bluffs, Ontario*

TOP OF THE WORLD

On October 3, 2015, myself and 12 others hiked up to Abbot Pass Hut, which is the second highest permanent structure in Canada, sitting at an altitude of 9,598 feet. The building straddles the Continental Divide, making it half in Alberta and half in British Columbia. After our 3,000-foot ascent, we patiently waited for the clouds to clear. Around 12:30 a.m. on October 4, the clouds broke up and I was able to snap a few pictures. The Big Dipper was prominent in the sky, with the clouds filling the valley to the north. It felt as if we were on the edge of a vast sea. Quite the experience! Camera: Sony Cyber-shot DSC-HX50V at ISO 1600, f/3.5 for a 15-second exposure.

*Lincoln Weller
Calgary, Alberta*

SUBMITTING LETTERS AND PHOTOS

SkyNews editor Terence Dickinson welcomes your letters about anything you read in the magazine. Submission of photos as attachments is encouraged. Send photos in jpeg format, keeping compressed file size to less than 3MB, to: dickinsonSkyNews@gmail.com.



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Background photo: Flame Nebula by Ken From of All-Star Telescope

ECLIPSE PIX

September's total eclipse of the Moon was well observed across Canada, as these readers' fine photos attest

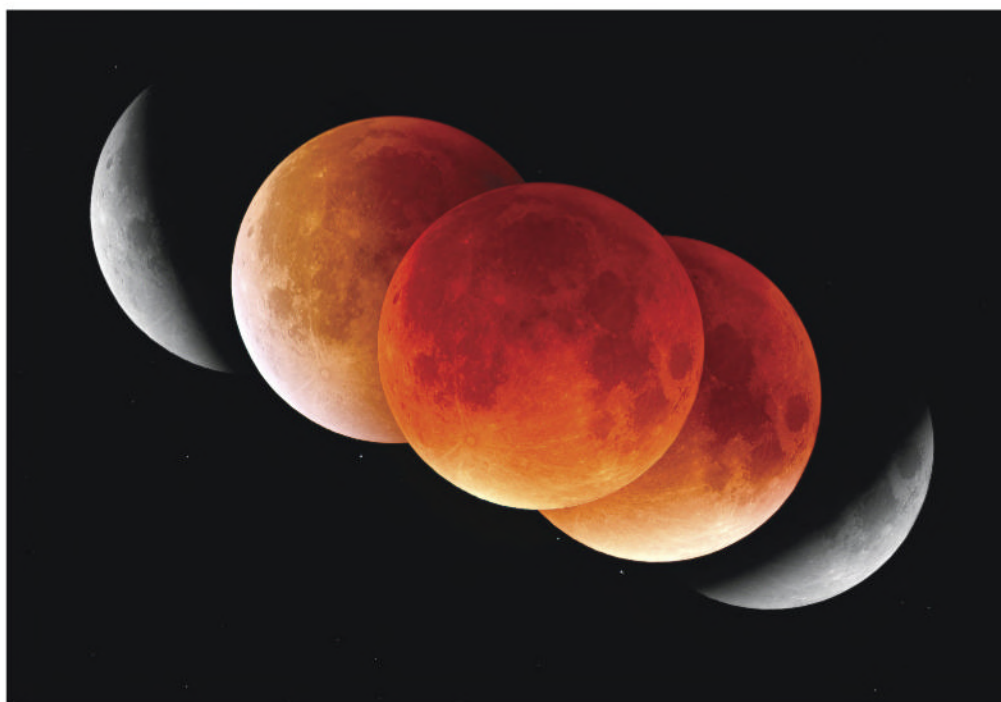
► **HARVEST MOON IN TOTAL ECLIPSE**

On the evening of September 27, observers with clear skies were treated to a richly shaded lunar eclipse. The ochre, rust and reddish hues are nicely recorded in this image at eclipse maximum by Bill McMullen in Cumberland, Ontario. The 1-second f/7 exposure was taken with a Canon 5D III, 500mm f/4 with a 1.4x extender, ISO 800.



► EVENING ECLIPSE

Like many eclipse watchers, Alberta's Gabriel Jones had to hit the road to see the event. "It was cloudy at my house, so to get out from under a cloud deck, I drove to the Sheep River valley. I thought escaping the clouds was hopeless, but lo and behold, there was the Moon. Or, at least, part of the Moon! It was the best eclipse I have seen."



▲ **COMPOSITE OF A BEAUTIFUL SIGHT** Key steps as the Moon dipped into and out of the Earth's shadow during the eclipse were captured and arranged in this montage by Jean Guimond of Quebec City. He used an SBIG STL-11000 CCD camera and an f/7.3 Takahashi 150mm apochromatic refractor. Exposure times range from 1.5 to 6 seconds for the luminance filter and 4 to 10 seconds for the RGB filters.

◀ **ECLIPSE UNFOLDING** To capture the sequence of events during the eclipse, Rod Hutson of Edmonton took 860 frames from the urban setting shown here. "The first 90 minutes of penumbral and umbral shadow phases took place below my eastern horizon," he reports, "so my Moon images start at lower left at about 7:54 p.m., MDT," and continue through totality and the partial phases to the end of the eclipse at upper right. Each image of the Moon was taken with a Nikon D7000 and a 70-300mm lens set at 270mm. Then, using Photoshop, Hutson digitally placed the images in the neighbourhood street view taken from the same viewpoint. The final image includes individual Moon frames selected at roughly 10-minute intervals in order to provide adequate separation yet still show the approximate alignment and details of the eclipse as it progressed. The mount used was the Sky-Watcher Star Adventurer in Moon tracking mode.

Top 10 SKY SIGHTS for 2016

A rare transit of Mercury and a close approach of Mars highlight the year of stargazing

AFTER A YEAR OF LUNAR ECLIPSES and close conjunctions in 2015, what does 2016 have in store for us?

The highlight has to be the transit of Mercury across the disc of the Sun on May 9, the first since 2006, with the next one not until 2019. It's a Monday, so be sure to book off time to see this unusual daytime event. While not as spectacular, historic or rare as a transit of Venus, Mercury transits are uncommon enough that even avid observers are likely to see only a handful in their lifetime.

The other highlight is a close approach of Mars, something that happens every two years. However, not all such "oppositions" are equal. At this year's approach, Mars comes closer and appears larger in our telescopes than it has since October 2005. That's the good news. The bad news is that from Canada, Mars will appear low in our southern sky, on the border of Libra and Scorpius. Its low altitude will certainly blur the elusive detail we'd like to see on the Martian disc.

"Exploring the Night Sky" (page 30) contains details on January and February sky events. Here are my top 10 picks for the best events for the rest of 2016.

—Alan Dyer



MONDAY, APRIL 18

1

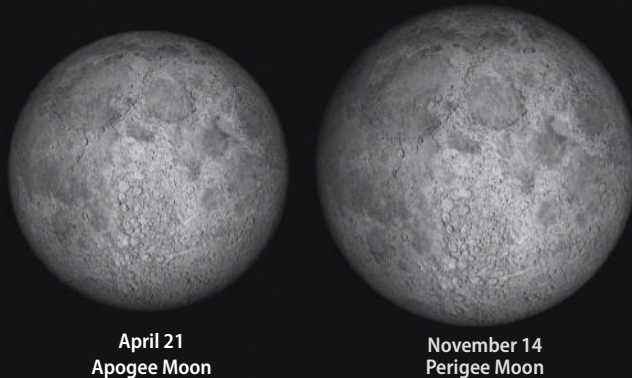
Mercury at its best for 2016

Spring brings the best time to see Mercury in its more normal habitat, shining in the twilight sky. On April 18, the inner planet reaches its greatest elongation east of the Sun, placing it in our western sky. For Canada, this is Mercury's highest evening appearance of the year, at a generous 10 degrees above the western horizon, shining below the Pleiades at a bright magnitude 0.3.

2

THURSDAY, APRIL 21, AND MONDAY, NOVEMBER 14

April and November MINI AND MAXI MOONS



Smallest and largest Moons

There's been much ado about supermoons of late. On November 14, 2016, the Moon will be closer to Earth than it will be until 2034, though the difference between November's perigee Moon and other very close Moons past and future is measured in a hair-splitting tens of kilometres. By contrast, April 21 is the most distant full Moon of 2016, so photographers wanting to capture a comparison pair should note these two full Moon dates.

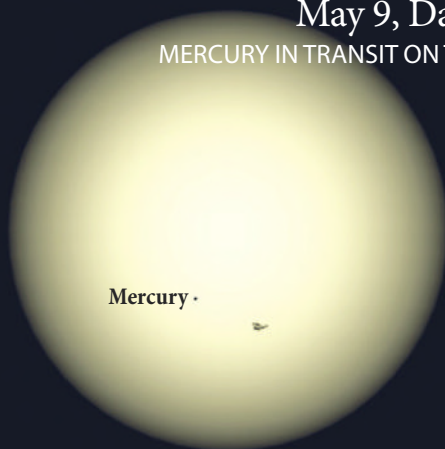
MONDAY, MAY 9

3

Transit of Mercury

All of Canada can see Mercury transit the disc of the Sun, but locations in southern Canada west of Winnipeg see the Sun rise with the seven-hour-long transit already in progress. Not until the Sun climbs away from turbulent "seeing" will Mercury's tiny black disc become obvious. The next Mercury transit is November 11, 2019, followed by one on November 13, 2032.

May 9, Daytime MERCURY IN TRANSIT ON THE SUN



May 30, All Night MARS AT CLOSEST APPROACH



MONDAY, MAY 30

4

Mars at closest approach

While Mars lies directly opposite the Sun on May 22, closest approach is on May 30. At that time, the Martian disc will appear 18.6 arc seconds across, the largest and closest it's been since the opposition of late 2005, when the disc reached 20.2 arc seconds. The above illustration shows the features visible in a large telescope from Canada on the night of closest approach. An even closer opposition awaits in July 2018, when Mars reaches 24.3 arc seconds, but with the red planet then even lower in our Canadian sky.

BEST CELESTIAL EVENTS OF THE YEAR

FRIDAY, JUNE 3

5

Saturn at opposition

For much of 2016, Saturn and Mars keep company as Mars retrogrades near Saturn. On June 3, Saturn reaches opposition, when it shines at its brightest for 2016. The rings are now spectacular, tilted open at 26 degrees all year, almost as wide as they can get. Despite Saturn's low altitude, the ringed planet will be a telescopic highlight of the spring and summer sky this year.

June 3, All Night
SATURN AT OPPOSITION



August 12, Evening
PEAK PERSEID NIGHT



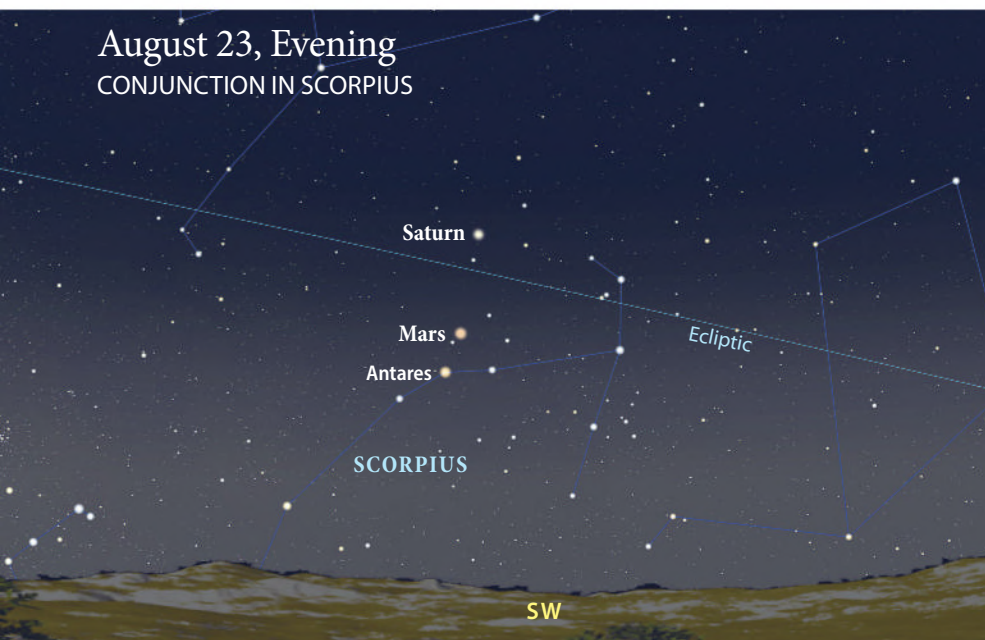
FRIDAY, AUGUST 12

6

Perseids peak in moonlight

Meteor showers fare poorly in 2016, with most spoiled by a bright Moon. The Perseids are beset by a gibbous Moon, but one that is low and sets by 2 a.m., local time. On the plus side, the shower peaks on a Friday night. However, the actual peak hour for North America is at dawn on Friday, so the night of Thursday, August 11, should be equally as good, with moonset an hour earlier.

August 23, Evening
CONJUNCTION IN SCORPIUS



TUESDAY, AUGUST 23

7

Mars and Saturn meet Antares

After Mars completes its retrograde loop west of Saturn this spring, the red planet takes off eastward to meet up with Saturn in Scorpius. On August 23 and 24, Mars shines four degrees directly below Saturn and just two degrees above Antares, its rival red star, forming a striking vertical line of "stars" in the summer evening sky. The grouping is tight enough to frame in binoculars.



ECLIPSES IN 2016

After a generous supply of four total lunar eclipses in the past two years, we now enter a drought, with no total eclipse of the Moon for anyone in the world until January 31, 2018. This year, we get the minimum number of eclipses any year can have: four, two each of the Sun and the Moon.

Total solar eclipse for Asia

TUESDAY, MARCH 8

This most spectacular of sky events can be seen along a narrow path only from South-east Asia and the western Pacific. The partial-eclipse zone just touches Alaska at sunset.

Penumbral lunar eclipse at dawn

WEDNESDAY, MARCH 23

Two weeks later, the full Moon passes through the Earth's outer penumbral shadow at dawn in an event best for western Canada. However, any darkening of the Moon will be impossible to detect, making this a nonevent for observers.

Annular solar eclipse for Africa

THURSDAY, SEPTEMBER 1

For a narrow zone across southern Africa, Madagascar and the Indian Ocean, the Moon passes centrally across the Sun but isn't large enough to totally eclipse it, creating a "ring of light" annular eclipse.

Penumbral lunar eclipse for Asia

FRIDAY, SEPTEMBER 16

Although it is a deep penumbral eclipse, the September 16 event is not visible from North America. However, it does coincide with the Harvest Moon, and the near alignment of the Sun, Earth and Moon will cause the Moon to rise in the east at almost exactly the same time as the Sun sets in the west.

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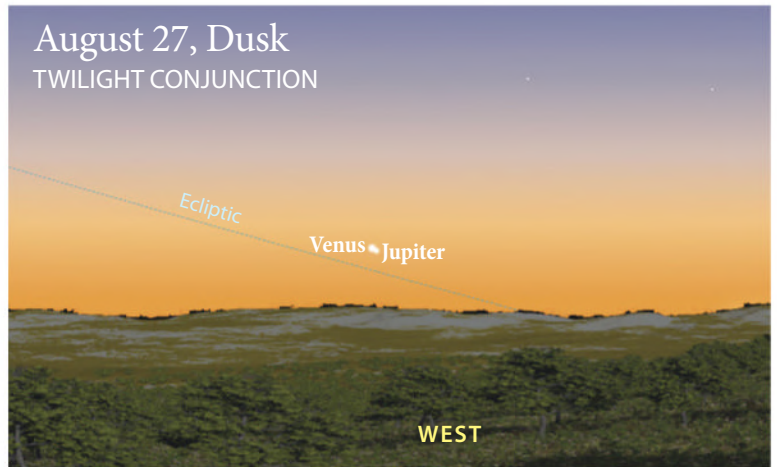
BEST CELESTIAL EVENTS OF THE YEAR

SATURDAY, AUGUST 27

8

Venus and Jupiter in close conjunction

Jupiter reaches opposition on March 8 and dominates the spring and early-summer sky. By August, the giant planet is sinking into the west but is joined by Venus for an amazingly close conjunction on August 27. The two are just 10 arc minutes apart, a third of a Moon diameter. The catch is that the two planets lie very low and are embedded in bright twilight, making this a binocular event.



September 28, Evening

MARS AND M8

Ecliptic

Lagoon Nebula

Mars

WEDNESDAY, SEPTEMBER 28

9

Mars below Lagoon Nebula

By the end of September, Mars has dropped below 10 arc seconds in diameter, making it even more challenging to discern telescopic detail on its disc. On September 28, however, a fine sight and photo op await as the red planet passes just one degree below the bright Lagoon Nebula, a.k.a. Messier 8. The Moon won't interfere, but the meeting occurs with Mars low in the southwest.

TUESDAY, OCTOBER 18

10

Gibbous Moon occults Aldebaran

The Moon passes in front of Aldebaran nearly every month this year, but most of these occultations are not visible from Canada. However, on the night of October 18/19, observers in eastern Canada can watch the waning gibbous Moon hide the bright star. From western Canada, the Moon passes just below Aldebaran. From northern Ontario and northern Quebec, the star can be seen grazing the Moon's northern edge.

October 18/19, Midnight

TWILIGHT CONJUNCTION

Aldebaran

Hyades cluster

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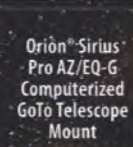
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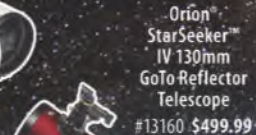
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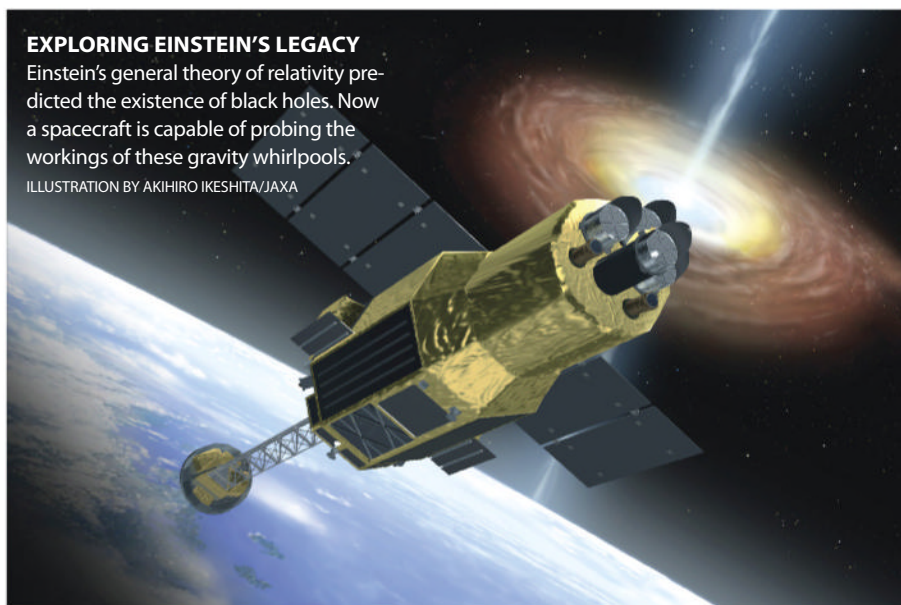
Probing the Secrets of Black Holes

A century after black holes were first theoretically suggested, our understanding of them should soon get a big boost

EXPLORING EINSTEIN'S LEGACY

Einstein's general theory of relativity predicted the existence of black holes. Now a spacecraft is capable of probing the workings of these gravity whirlpools.

ILLUSTRATION BY AKIHIRO IKESHITA/JAXA



IN JANUARY 1916, Albert Einstein found himself in possession of a remarkable document.

Only weeks earlier, he had unveiled his general theory of relativity, a radical new approach to gravity. Now, to Einstein's delight, a manuscript had arrived in his mailbox in Berlin that contained the first exact solution to general relativity's field equations.

The paper's author was Karl Schwarzschild, an astronomer and a soldier who had taken up relativity as a distraction from the battlefield.

Schwarzschild was no junior conscript. At age 42, he was six years Einstein's senior and the director of the Potsdam Observatory. A father of three, he had volunteered to serve in the German Army at the outbreak of World War I.

During the war, Schwarzschild applied his mathematical talents to calculating the

trajectories of long-range artillery shells. But in his spare time, he was absorbed with the motion of celestial bodies in Einstein's curved space-time. In a letter to Einstein, he wrote how much he relished the opportunity "to take this walk into your land of ideas."

That walk was all too brief. Schwarzschild died on May 11 of an autoimmune disease contracted in the trenches. Yet his mathematical legacy would continue to grow in significance. By recasting Einstein's equations in a clearer form, Schwarzschild had stumbled across an astonishing corollary: General relativity permits a region of space to be so severely curved by a sufficiently dense concentration of mass that it traps light.

In short, Schwarzschild had discovered that black holes can exist.

One hundred years later, it is well known that black holes are not only possible but

detectable. In 1964, a mysterious X-ray source in the constellation Cygnus offered the first clue. It was eventually linked to a blue supergiant star designated HD 22686. Then, in 1971, astronomer Tom Bolton at the David Dunlap Observatory, north of Toronto, and a team at the Royal Observatory, Greenwich, in the U.K., independently discovered that the star is orbited by an unseen companion whose mass is so great, it can only be a black hole. The X-rays are now understood to come from superheated matter that has been stripped off the star and is being funnelled into the black hole.

Since then, many more black holes have been discovered, including a massive solar-system-sized specimen at the centre of our galaxy. Our very existence may be connected to this monster. Although the link is not well understood, it is thought that high-velocity material flowing away from the highly energized region immediately around a giant black hole can affect star formation in the surrounding galaxy.

Other details about black holes remain equally murky, including the exact process by which they generate such powerful X-rays. "We don't really have a true concept of how this works," says Luigi Gallo, an astrophysicist at Saint Mary's University, in Halifax, who studies black holes.

X-rays from space are absorbed by the Earth's atmosphere, so it takes an orbiting telescope to see them. Japan's ASTRO-H satellite, expected to launch in early 2016, is designed for this role, and it will explore the high-energy X-ray spectrum with unprecedented precision. That makes it the ideal tool for probing the extreme environments around black holes, says Gallo.

While optical telescopes use mirrors that are nearly perpendicular to incoming

light rays, X-ray telescopes must employ a different strategy. X-ray photons are too energetic to bounce off a mirror head-on—they would simply plow right through the mirror's surface. But X-rays can be focused using tapered cones of metal that redirect high-energy photons coming in at a slight grazing angle. The more energetic the X-rays, the shallower the angle and the longer the focal length of the telescope.

ASTRO-H (it will be renamed by the Japanese space agency after a successful launch) is built to focus high-energy X-rays up to 80 keV and to detect them all the way to 600 keV. This calls for a staggering 12-metre-long focal length. The most economical way to do this is to build a telescope that can grow in length after it is launched. ASTRO-H features an extendable optical bench that places its detectors at the appropriate distance from its focusing elements. Such a setup is problematic because minute vibrations and thermal fluctuations make it impossible to keep the opposite ends of a long, lightweight satellite precisely separated from each other.

Canada has provided the solution with a laser alignment system built by Neptec Design Group of Ottawa. The laser will continuously measure tiny displacements along the path of the incoming X-rays, allowing ASTRO-H to compensate for its internal distortions.

In return, Gallo and his team will be among those to analyze the extraordinarily sharp images and spectral data that are expected from ASTRO-H. Last October, the group made news by using observations from other satellites to determine that an X-ray flare-up in the galaxy Markarian 355 was due to a high-speed ejection of gas near that galaxy's giant black hole. It's precisely the kind of process they hope to study in detail once ASTRO-H is launched.

"I've always been interested in black holes," says Gallo about the subject that first drew him into astronomy. Now, after eight years of working on ASTRO-H, he says, "It's amazing to imagine what the satellite will finally reveal, a full century after black holes first popped out of Karl Schwarzschild's battlefield calculations." ♦

Ivan Semeniuk is a science reporter for The Globe and Mail newspaper and website.



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5.5 LIGHT-HOURS FROM EARTH

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CHARON

During New Horizons' rapid swing past Pluto, the spacecraft's cameras recorded this superbly detailed image of Pluto's large moon Charon, which sports a canyon larger than the Earth's Grand Canyon. The moon's surface appears to be water ice, which is as hard as granite in the frigid outer solar system five billion kilometres from the Sun. The origin of the reddish patch near the north pole remains a mystery. Compare with Pluto at the same scale, next page. COURTESY NASA (ALL)



5.5 LIGHT-HOURS FROM EARTH

PLUTO CLOSE-UP

Exactly half a century after the Mariner 4 spacecraft sent back to Earth the first fuzzy close-up of a planet (Mars), New Horizons has given us this detailed portrait of the last of the traditional planets in our solar system. As it hurtles away from its close encounter with Pluto, the spacecraft will slowly transmit more pictures from the album gathered during its flyby.

A WORLD LIKE NO OTHER “Pluto has a diversity of landforms and complexity of processes that rival anything we’ve seen in the solar system,” says New Horizons principal investigator Alan Stern. “If an artist had painted this before our flyby, I probably would have called it over the top—but that’s what is actually there.” The view at left reveals features as varied and unexpected as possible dunes, nitrogen ice flows, which apparently oozed out of mountainous regions onto plains, and even networks of valleys that may have been carved by material flowing over Pluto’s surface. It also shows large regions that display chaotically jumbled mountains reminiscent of disrupted terrains on Jupiter’s icy moon Europa. “The surface of Pluto is every bit as complex as that of Mars,” says Jeff Moore, leader of the New Horizons Geology, Geophysics and Imaging team. “The randomly jumbled mountains might be huge blocks of hard water ice floating within a vast, denser, softer deposit of frozen nitrogen in the region informally named Sputnik Planum.” At the centre of the side of Pluto the New Horizons imaged, we see the most heavily cratered—and thus oldest—terrain next to the youngest, most crater-free icy plains. There might even be a field of dark windblown dunes, among other possibilities.

OUTWARD BOUND The image below was taken 15 minutes after New Horizons’ closest approach to Pluto on July 14, 2015, as the spacecraft looked back at Pluto while heading outward from the Sun. The wide-angle perspective shows the haze layers of Pluto’s thin atmosphere. On the sunlit side of Pluto, the smooth expanse of the informally named icy plain Sputnik Planum (top) is flanked by rugged mountains up to 3,500 metres high. The back-lighting highlights more than a dozen high-altitude layers of haze in Pluto’s tenuous atmosphere. The image was taken with New Horizons’ Multispectral Visible Imaging Camera from a distance of 18,000 kilometres. Resolution of detail is similar to what a visual observer on Earth would see using an 8-inch telescope to observe our Moon.

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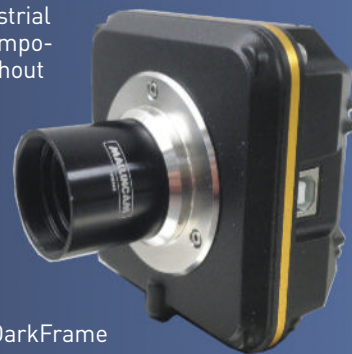
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A 'CRYSTAL BALL' IN TAURUS

NGC1514, a shell of gas 800 light-years away, is small and very faint.

Can we see it in a backyard telescope? by Ken Hewitt-White

ALTHOUGH WELL PLACED IN NORTHERN TAURUS, the planetary nebula **NGC1514** is a challenge for city and suburban observers. The optimistically named Crystal Ball Nebula boasts a prominent central star, but the 2.3-arc-minute-wide cloud enveloping the star is diffuse and glows wanly at magnitude 11. That said, an eyepiece filter might reveal the object as it climbs high overhead on late-autumn nights. Let's give it a try.

NGC1514 lies eight degrees northeast of the Pleiades cluster, near the Taurus-Perseus border. The nearest bright star to the nebula is 2.8-magnitude **zeta (ζ) Persei**. I always zero in on zeta because it's a binary star with "extras." The official 9.2-magnitude secondary sun is 12.7 arc seconds south of the glaring primary. In the same direction, approximately eight times farther out, are two 10th-magnitude stars 30 arc seconds apart. And a fainter star lies roughly 45 arc seconds west of the primary. Unofficially, zeta is a five-star family.

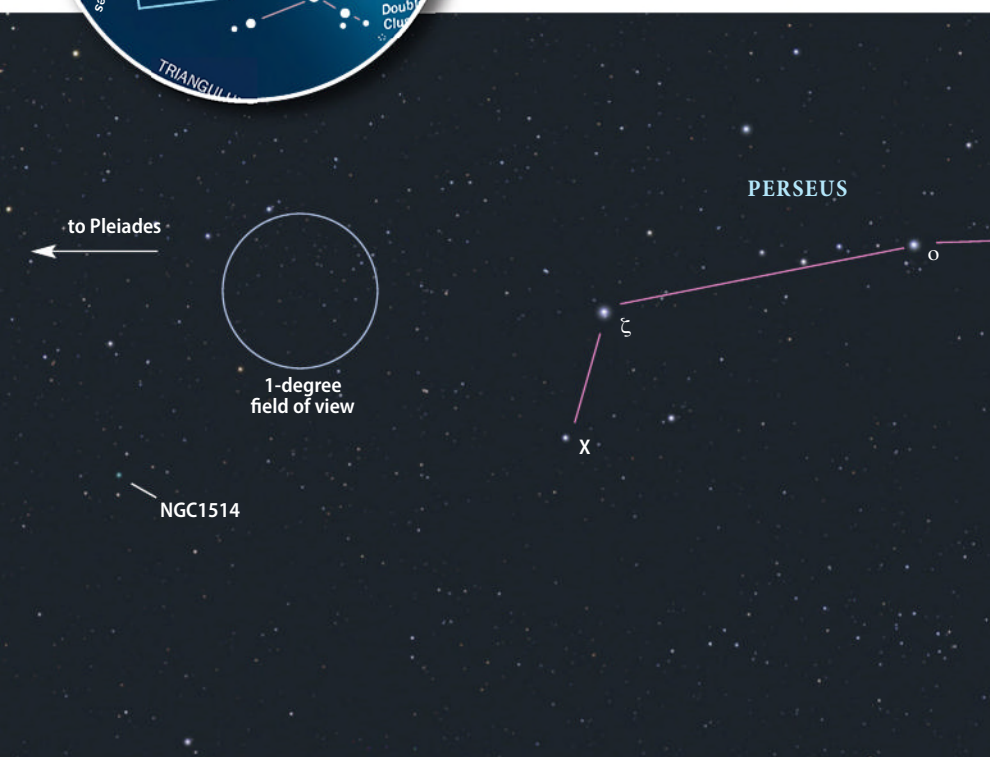
FOLLOW KEN'S DIRECTIONS TO NGC1514

To some observers, the constellation Perseus resembles a ragged "K," with one arm reaching toward the Pleiades star cluster. That arm is the starting point for the hunt for the planetary nebula NGC1514, a faint puff of gas with an interesting history. MAIN CHART BY GLENN LEDREW

Zeta Persei is where I begin my star-hop to NGC1514. Just south of zeta are two sixth-magnitude stars $\frac{3}{4}$ degree apart that aim eastward to the target area. The eastern member of that pair is an X-ray source called X Persei. From X Persei, I sweep three degrees east to an inconspicuous right-angle triangle $\frac{1}{3}$ degree wide, formed by 8.1-, 8.4- and 8.7-magnitude stars. The two brightest stars, barely more than $\frac{1}{4}$ degree apart, form the triangle's "upright" west-facing side. The dim, delicate Crystal Ball awaits our scrutiny between these two stars.

One night late last summer, I found NGC1514 using my 10-inch f/5.5 Dobsonian. It was a predawn observation made when the nebula was halfway to the zenith. My suburban sky was better than usual—a 5.1-magnitude star near the target was visible to my bare eyes. I decided to use two eyepieces, one of 24mm focal length yielding 58x and the other of 9mm focal length giving 155x. The 58x eyepiece easily framed the three-star triangle, and right away, I noticed the planetary's 9.4-magnitude central star on the triangle's west side, between the 8.4- and 8.1-magnitude flanking stars. To my surprise, my averted vision picked up a faint halo around the central star. At 155x, the halo glowed more strongly. I knew the effect was real because the flanking stars were halo-free. (Note: Those "flankers" made handy focusing points with each change of ocular.)

What about filtered views? To find out, I started off with a basic light-pollution filter. At both magnifications, the nebula was a faint but definite fuzz around the central star. With an Ultra High Contrast (UHC) filter at 58x, the central star remained bright but the haze enveloping it became distinctly spherical. At 155x, the nebulosity was unevenly bright across its face. I then selected a doubly ionized oxygen (O-III) filter, often the best choice for suppressing a central star and enlivening the nebula.





DEEP-SKY TARGET Looking much fainter in telescopes than in this long-exposure photo, NGC1514 is an observing challenge. NOAO PHOTO

The low-magnification view with that filter revealed an obvious spherical glow around a significantly dimmer star. High power produced a vaguely doughnut-like structure, but with the surrounding star field unappealingly dark. I preferred the UHC view. By the way, I employed averted vision at all times. Staring directly at the bright central star caused the nebulosity to disappear, regardless of filter.

One of my observing colleagues, David

Rodger of North Vancouver, B.C., lives in a townhouse complex close to a major city artery and several high-rises. David has observed NGC1514 using equipment similar to mine. Indeed, it was David's city-based report that inspired me to try for NGC1514 at home with my 10-inch Dob. Since then, I've detected it with my 4¼-inch f/6 Newtonian employing 72x and a UHC filter. At 93x plus an O-III filter, the central star is almost totally blocked, leaving just the pale nebulosity. However, the surrounding star field isn't visible. As with my bigger backyard scope, the lighter UHC view wins me over every time.

NGC1514 was discovered in 1790 by the great German-English astronomer William Herschel. For Herschel, this object posed a

problem. Up until that point, he was convinced that all nebulas were actually clusters of stars too remote to resolve. Yet here was a single star enveloped in a "faintly luminous atmosphere." Herschel concluded that the nebulosity "is not of a starry nature," and of course, he was right. Modern-day astronomers have been investigating the luminous central star. According to observations made in 2010 by the Earth-orbiting WISE satellite, it comprises an ageing giant and a white dwarf in a tightly bound binary system.

As the New Year opens, NGC1514 is halfway up the eastern sky at nightfall. The first 10 evenings of January are free of moonlight. Weather permitting, it will be a perfect time to try for this elusive planetary—and zeta Persei too. ♦

Contributing editor Ken Hewitt-White has observed deep-sky fuzzies over southern British Columbia for more than four decades.

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OUR CHART SHOWS the major stars, planets and constellations visible from Canada and the northern United States within one hour of these times:

EARLY JANUARY: 11 P.M.; LATE JANUARY: 10 P.M.

EARLY FEBRUARY: 9 P.M.; LATE FEBRUARY: 8 P.M.

THE EDGE OF THE CHART represents the horizon; the overhead point is at centre. On a moonless night in the country, you will see more stars than are shown here; deep in the city, you will see fewer. The ecliptic is the celestial pathway of the Moon and planets. The star groups straddling this line are known as the zodiac constellations. The Moon is shown for selected dates.

USING THE STAR CHART OUTDOORS: The chart is most effective when you use about one-quarter of it at a time, which roughly equals a comfortable field of view in a given direction. Outdoors, match the horizon compass direction on the chart with the actual direction you are facing. Don't be confused by the east and west points on the chart lying opposite their location on a map of the Earth. When the chart is held up to match the sky, with the direction you are facing at the bottom, the chart directions match the compass points. For best results when reading the chart outdoors, use a small flashlight heavily dimmed with red plastic or layers of brown paper. Unfiltered lights greatly reduce night-vision sensitivity.

CELESTIAL CALENDAR

JAN. 1 ☞ Comet Catalina $\frac{1}{2}^\circ$ from Arcturus in predawn hours

JAN. 2 Last-quarter Moon; Earth closest to Sun for the year (perihelion at 147,100,176 km)

JAN. 3 Waning crescent Moon 2° from Mars and near Spica in dawn sky; Quadrantid meteor shower peaks tonight

JAN. 6 Waning crescent Moon near Venus and Saturn in dawn sky

JAN. 8 ☞ Venus and Saturn $\frac{1}{2}^\circ$ apart today and tomorrow in dawn sky

JAN. 9 New Moon, 8:31 p.m., EST; Jupiter begins retrograde motion

JAN. 16 First-quarter Moon

JAN. 19 ☞ Waxing gibbous Moon occults Aldebaran in evening sky for all of Canada

JAN. 23 Full Moon, 8:46 p.m., EST

JAN. 27 Waning gibbous Moon 4° from Jupiter in late-night sky

JAN. 31 Last-quarter Moon

FEB. 1 Waning crescent Moon 2° from Mars in dawn sky

FEB. 3 Waning crescent Moon 3° from Saturn in dawn sky

FEB. 6 ☞ Thin waning crescent Moon 2° above Mercury and 5° from Venus

FEB. 7 Mercury at greatest elongation from Sun (26°) in dawn sky

FEB. 8 New Moon, 9:39 a.m., EST

FEB. 15 First-quarter Moon; Moon within Hyades star cluster

FEB. 22 Full Moon, 1:20 p.m., EST

FEB. 23 Waning gibbous Moon 2° below Jupiter in late-evening sky

FEB. 24 Zodiacal light visible in west for next two weeks in evening sky

FEB. 29 Leap day! Waning gibbous Moon 3° above Mars in dawn sky

☞ *Impressive or relatively rare astronomical event*

THE PLANETS

MERCURY begins the year with an appearance in the western twilight but soon drops out of sight close to the Sun, reaching inferior conjunction on Jan. 14. It reappears in the eastern dawn sky, reaching greatest elongation away from the Sun on Feb. 7. It then also appears close to Venus.

VENUS shines brightly at magnitude -4 in the morning sky, passing within $\frac{1}{2}^\circ$ of Saturn on the mornings of Jan. 8 and 9. Look for the waning crescent Moon near Venus on Jan. 6 and again on Feb. 6, when Venus also appears near Mercury.

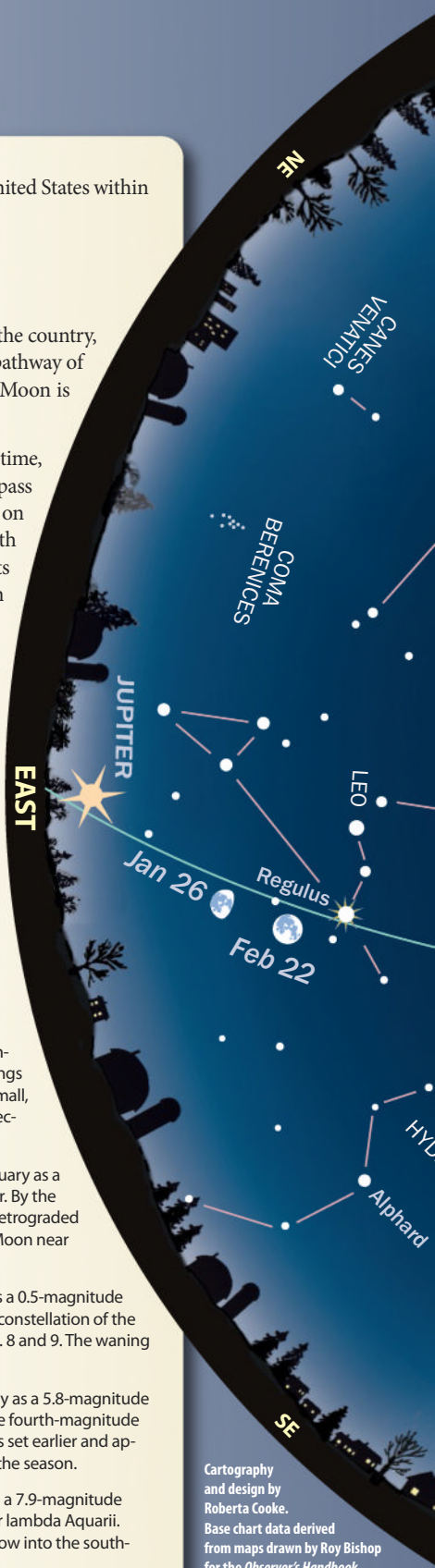
MARS can be seen as a reddish object in the early-morning hours and at dawn. It brightens from magnitude 1.3 to 0.3 as it moves from Virgo into Libra this winter. Look for the waning Moon near Mars on the mornings of Jan. 3, Feb. 1 and Feb. 29. The disc of Mars remains small, growing from 5.6 arc seconds on Jan. 1 to just 8.7 arc seconds on March 1.

JUPITER can be seen rising around 11 p.m. in early January as a bright object (magnitude -2.2) on the Leo-Virgo border. By the end of February, Jupiter is rising about 7 p.m. and has retrograded back into southern Leo. Look for the waning gibbous Moon near Jupiter as they rise together on Jan. 27 and Feb. 23.

SATURN appears low in the dawn twilight this winter as a 0.5-magnitude object in the southern portion of Ophiuchus, the 13th constellation of the zodiac. Venus and Saturn appear close together on Jan. 8 and 9. The waning crescent Moon passes near Saturn on Jan. 6 and Feb. 3.

URANUS appears due south at nightfall in early January as a 5.8-magnitude object in southern Pisces. Look for it about 2° below the fourth-magnitude star epsilon Piscium. Over the winter, Pisces and Uranus set earlier and appear lower in the southwest sky. Catch Uranus early in the season.

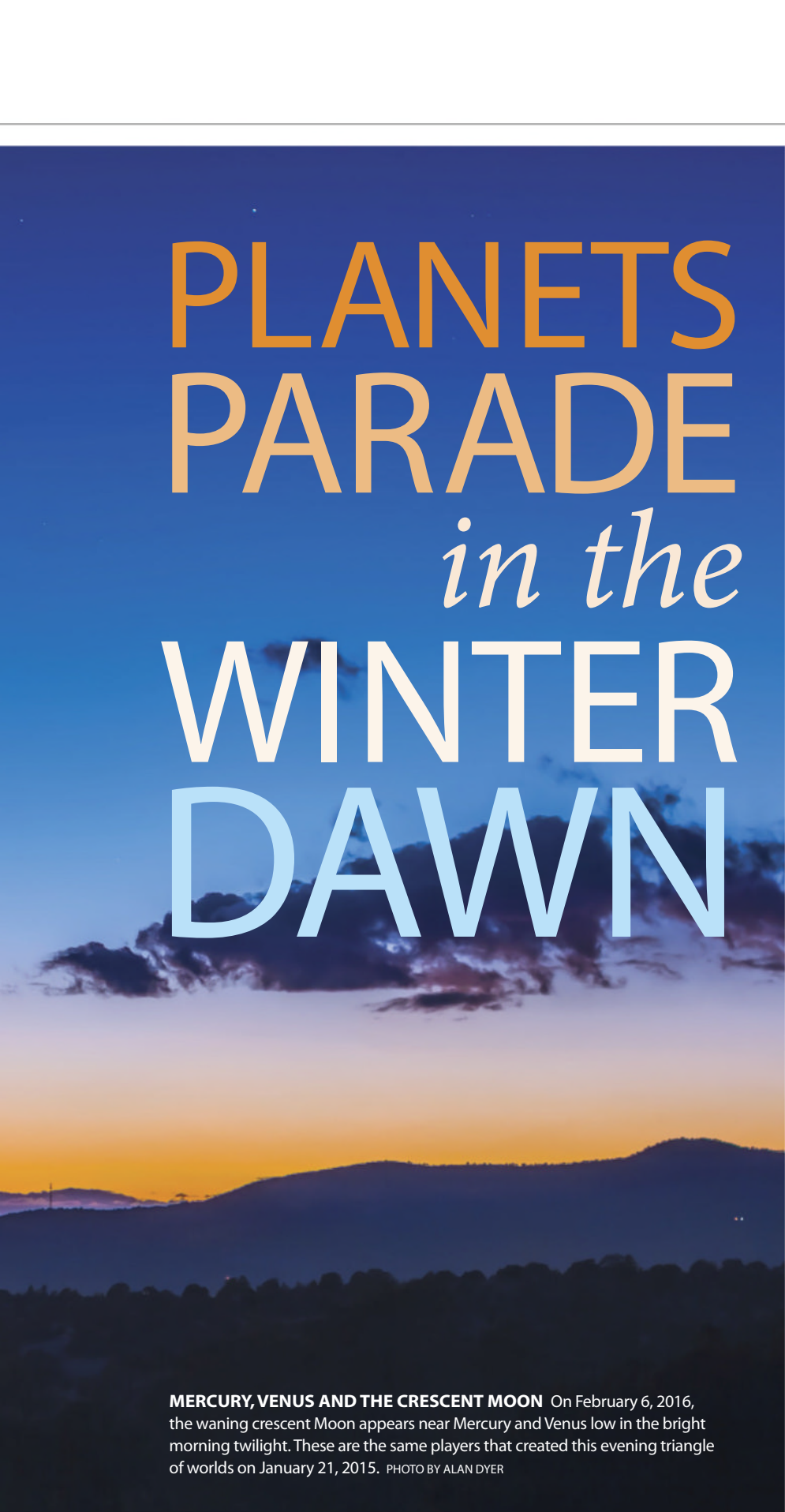
NEPTUNE can be seen early in January in binoculars as a 7.9-magnitude bluish "star" about 4° west of the fourth-magnitude star lambda Aquarii. Over the winter, however, Aquarius and Neptune sink low into the southwest to disappear into the twilight.



Cartography and design by Roberta Cooke. Base chart data derived from maps drawn by Roy Bishop for the *Observer's Handbook*, published by The Royal Astronomical Society of Canada.

EXPLORING THE NIGHT SKY





PLANETS PARADE *in the* WINTER DAWN

MERCURY, VENUS AND THE CRESCENT MOON On February 6, 2016, the waning crescent Moon appears near Mercury and Venus low in the bright morning twilight. These are the same players that created this evening triangle of worlds on January 21, 2015. PHOTO BY ALAN DYER

Mercury, Venus, Mars and Saturn all appear in the early-morning sky performing a series of mutual meetings, some with the waning Moon

by Alan Dyer

AS IN LATE AUTUMN in 2015, most of the planetary action happens in our dawn sky this winter, with four of the five naked-eye planets all appearing at one time or another in the morning twilight. Venus and Saturn are the “stars” as they pass just half a degree apart on January 8 and 9. Venus then drops lower but joins Mercury briefly in early February, including a meeting with the Moon on February 6.

Meanwhile, Comet Catalina moves from being a dawn object to becoming an all-night circumpolar target as it recedes from the Sun. It opens the year with a very close passage by the brilliant star Arcturus on New Year’s Day morning.

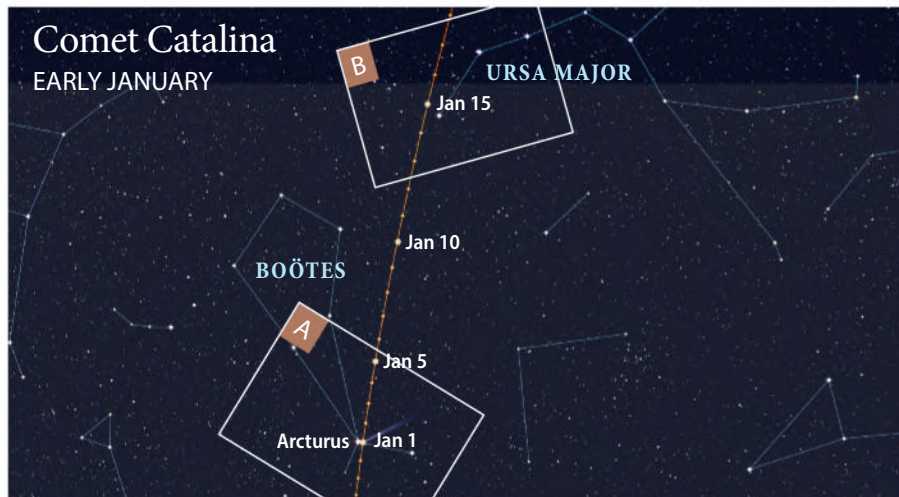
COMET CATALINA COMES NORTH

Discovered in Arizona in 2013 by one of the world’s automated asteroid search programs, Comet Catalina (C/2013 US10) promises to be the best comet of 2016, at least that we know about as of late 2015.

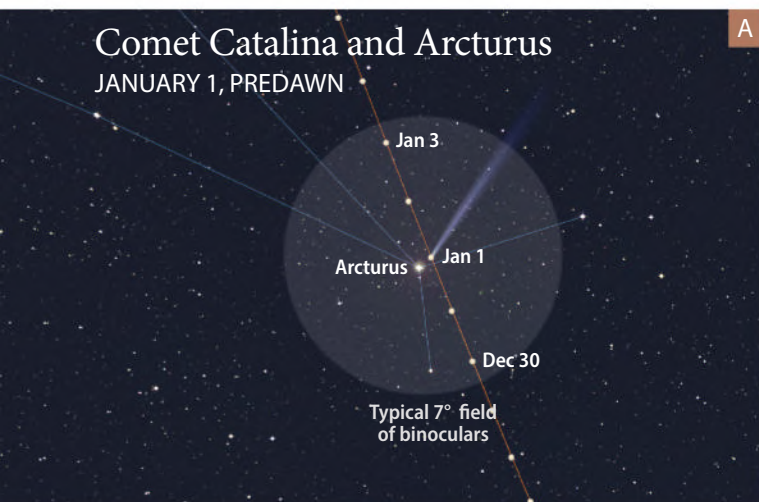
Comet LINEAR (252P) will come unusually close to Earth on March 21, passing just five million kilometres away, making it the fifth closest comet approach on record, according to the British Astronomical Association. Even so, 252P is not expected to get brighter than 10th magnitude. Comet Honda-Mrkos-Pajdusakova (45P) might reach seventh magnitude in early December 2016, when it will appear near Venus. But it will be low in the western twilight and likely a difficult catch. So Catalina remains our best cometary hope for 2016.

COMET IN THE WINTER DAWN

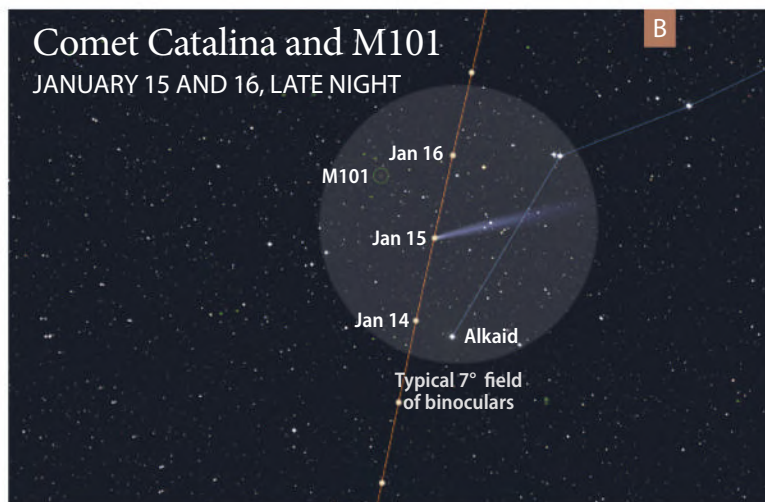
On January 1, Comet Catalina passes just $\frac{1}{2}$ degree from Arcturus. Will it have a tail visible in binoculars, as shown here [A]? Or might it appear only as a fuzzy star? We do know that its path takes it north through Boötes and into Ursa Major, where it passes above the handle of the Big Dipper in mid-January, perhaps still shining at fifth magnitude. On January 15 and 16, the comet passes 2.5 degrees from M101, the Pinwheel Galaxy [B].



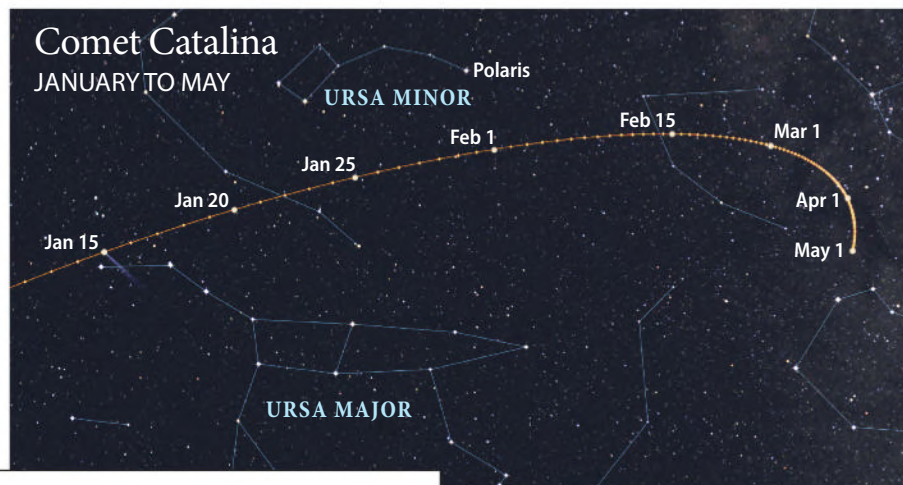
Comet Catalina and Arcturus JANUARY 1, PREDAWN



Comet Catalina and M101 JANUARY 15 AND 16, LATE NIGHT



Comet Catalina JANUARY TO MAY



CATALINA PASSING POLARIS By late January and early February, Comet Catalina has become a circumpolar object visible all night as it passes near Polaris and is—perhaps!—still an easy target for binoculars from a dark site. It then moves into Camelopardalis in late winter and into spring as it heads away from the Sun, quickly fading to a dim telescopic object. COURTESY STARRY NIGHT PRO PLUS™/SIMULATION CURRICULUM CORP. (ALL)

As it approached the Sun in August, Comet Catalina performed up to expectations as it moved through the southern-hemisphere sky, appearing then at seventh magnitude, exactly as predicted, and sporting a short tail. It became lost in the solar glare from September to November.

Moving away from the Sun following its November 15 perihelion, Catalina tracked

north and began to appear in our northern-hemisphere sky as a dawn object in early December. The comet was then predicted to shine at magnitude 4.8. But as of this writing, we don't know how well it lived up to expectations. A fifth-magnitude comet is technically bright enough to be naked eye but more likely rates as a nice binocular and photographic comet.

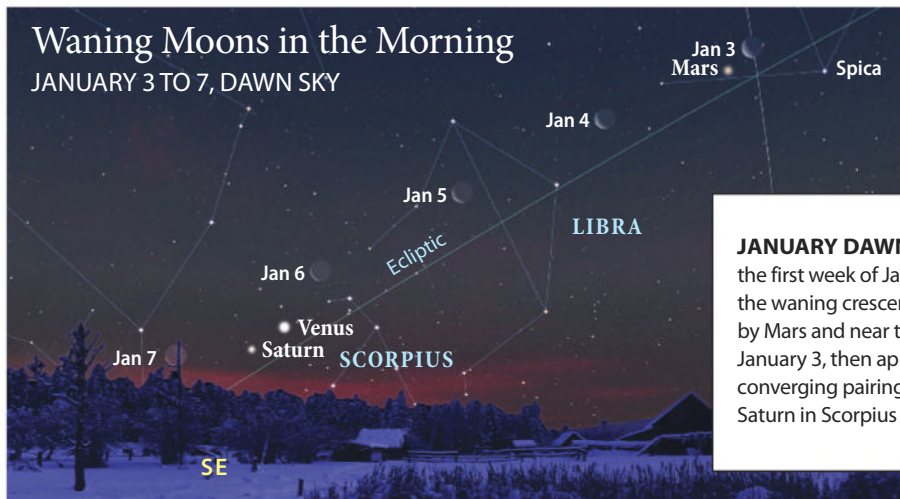
The year opens with Comet Catalina appearing amazingly close to Arcturus. On the morning of January 1, the comet passes just $\frac{1}{2}$ degree from this brilliant zero-magnitude star. That's close enough to frame in a telescope. If the comet does have a tail, this could be a fine binocular sight and a great photo op. But taking advantage of the opportunity requires getting up before dawn on New Year's Day. Don't party too late ringing in 2016.

Or just stay up. The comet and star will rise about midnight but won't be high enough to photograph or see well until one to three hours later.

Throughout January, Comet Catalina

Waning Moons in the Morning

JANUARY 3 TO 7, DAWN SKY



JANUARY DAWN MOONS In the first week of January, look for the waning crescent Moon passing by Mars and near the star Spica on January 3, then appearing near the converging pairing of Venus and Saturn in Scorpius on January 6.

Look due south at dawn, and you'll see Mars, now brightening as we approach the red planet this winter and spring. Over the two months from January 1 to March 1, it gains a full magnitude, from +1.3 to +0.3.

Look for the crescent Moon near Mars on January 3, February 1 and again on February 29.

The disc of Mars, however, remains small, growing from a tiny 5.6 arc seconds on January 1 to a still small 8.7 arc seconds on March 1. Not until March 16 does the disc of

Mars exceed 10 arc seconds across, often considered the minimum diameter to see telescopic detail on the planet.

Mars begins the year in Virgo, shining near Spica. Through the winter, it moves eastward into Libra in February, then into Scorpius in March, where it joins Saturn shining next door in southern Ophiuchus. The Mars and Saturn pairing will become a familiar sight in the spring and summer sky. But for now, enjoy the growing presence of Mars in our morning sky as it heads toward a bright and close approach in May.

DAWN PLANETS: VENUS AND SATURN

Venus and Saturn provide the best planetary show of the winter. As Venus drops back closer to the Sun, it passes Saturn on the mornings of January 8 and 9, appearing just $\frac{1}{2}$ degree (30 arc minutes) from Saturn each morning.

The two planets actually pass each other even closer than that, at an astonishingly close five arc minutes apart. But that minimum separation occurs on the evening of January 8 for North America, putting them below our horizon. You would have to be in Europe on the morning of January 9 to see Venus and Saturn at their absolute closest in the morning sky.

Although the two planets appear close, they are hardly equally matched. Venus shines at magnitude -4.0 , while Saturn is only a modest magnitude $+0.5$. The brilliance of Venus might overpower Saturn in naked-eye views, but the pairing will be obvious in binoculars.

Look low in the southeast between 6 a.m. and 7 a.m., local time. Make the effort, and you'll be rewarded with a view of one of the closest and best planet con-

Waning Moons in the Morning

FEBRUARY 1 TO 4, DAWN SKY



FEBRUARY DAWN MOONS A month later, the waning crescent Moon is back near Mars for a close conjunction at dawn on February 1. Two mornings later, the thinner crescent Moon shines near Saturn and above Antares, but Venus has departed the scene. COURTESY STARRY NIGHT PRO PLUS™/SIMULATION CURRICULUM CORP (BOTH)

climbs higher in the sky as it continues its trek north and transitions from a morning object to an all-night target. Depending on your latitude in Canada, by mid- to late January, the comet has travelled far enough north to be circumpolar, placing it in our northern sky all night.

In mid-January, the comet passes above the handle of the Big Dipper. The nights of January 15 and 16 bring a good photo opportunity for deep-sky imagers, as the comet passes 2.5 degrees from M101 (the face-on spiral galaxy pictured on page 4 of the November/December *SkyNews*). After the quarter Moon sets at midnight to 1 a.m., the sky will be dark and the comet higher in the sky in the north, good circumstances for a unique image of a comet near a large galaxy.

While Catalina passed closest to the Sun in November, it passes closest to Earth on

January 17, though at a distant 108 million kilometres. Still, the fact that we are approaching the comet in early January makes up for its dimming as it recedes from the Sun, keeping Catalina at a constant magnitude 5 or so in early January. As our separation from the comet increases, Catalina begins a rapid decline in brightness after January 17, dropping to an expected magnitude 6 by February 1 and magnitude 8.5 by March 1. So catch Catalina early in the New Year for the best view in a moonless sky.

DAWN PLANETS: MARS

Yes, it's cold out there, but some fine sights await those who venture outside on winter mornings this year. Nor does it have to be too early, as the sky doesn't begin to brighten with dawn twilight until 7 a.m., local time, in early January.

junctions of 2016. Only the Venus-Jupiter conjunction of August 27 matches the Venus-Saturn pairing of January 8/9 for how close the participating planets appear to each other. However, the August 27 conjunction occurs with Venus and Jupiter very low in the evening twilight.

MERCURY MOVES FROM DUSK TO DAWN

This winter, you can see Mercury both as an evening and a morning “star” within just a month. The year opens with Mercury ending a decent evening appearance. You can catch it low in the southwest during the first

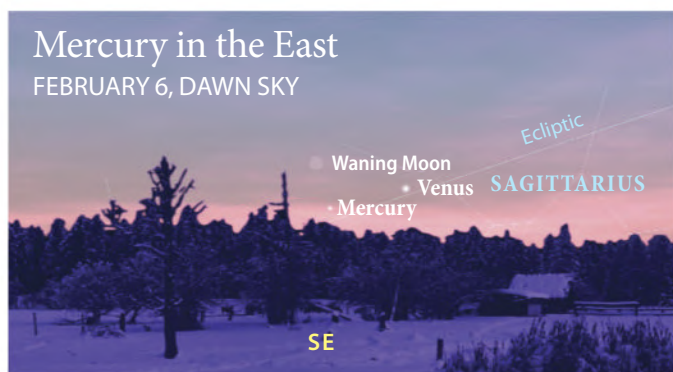
week of January shining at magnitude -0.4 on January 1.

As Mercury is wont to do, it then moves quickly toward the Sun, passing between us and the Sun at inferior conjunction on January 14. The next time Mercury reaches inferior conjunction, on May 9, it will actually



CLOSE CONJUNCTION AT DAWN Venus and Saturn provide one of the best conjunctions of the year on the mornings of January 8 and 9 when they appear about $\frac{1}{2}$ degree apart as seen from North America. Venus appears above Saturn on January 8 but below the ringed planet on January 9.

COURTESY STARRY NIGHT PRO PLUS™/SIMULATION CURRICULUM CORP. (BOTH)



FLEETING EVENING ‘STAR’ Mercury begins 2016 as an evening object low in the southwest in the first week of January but soon drops too close to the Sun to see. It reappears a month later on the other side of the Sun as a morning ‘star,’ where it joins Venus.

INNER-PLANET MORNING ‘STARS’ Mercury reaches its greatest elongation from the Sun in the morning sky on February 7. The morning before, the thin waning crescent Moon shines above Mercury and near Venus, for a binocular gathering low in the twilight.

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LATE-NIGHT MEETING The prime planet entering the evening sky this winter is Jupiter. On January 27, the waning gibbous Moon appears near Jupiter as both rise together about 9 p.m., local time.

EVENING TRYST A month later, the Moon, now only a day past full, passes even closer to Jupiter, just two degrees away, with the duo now rising two hours earlier for an evening pairing in the eastern sky.

COURTESY STARRY NIGHT PRO PLUS™/SIMULATION CURRICULUM CORP. (BOTH)

pass across the Sun in a rare transit. And before that, in April, it will shine much higher in our evening sky in its best evening appearance of 2016.

But this winter, Mercury emerges from the Sun's glare, postconjunction, in early February to shine in our eastern predawn sky. While this is not a particularly favourable appearance from Canada, Mercury does appear near Venus in the dawn sky. Mercury is at its highest and closest to Venus on February 7, when it reaches greatest elongation from the Sun.

The morning before, on February 6, the thin waning crescent Moon shines above Mercury and Venus for an excellent binocular scene for those with a low horizon to the southeast. Then at zero magnitude, Mercury is four magnitudes dimmer than Venus. But in binoculars, bright, obvious Venus should make it easy to locate more elusive Mercury to the left and the razor-thin Moon above.

JUPITER ENTERS EVENING SKY

Apart from Mercury's brief evening sojourn, we have no other naked-eye planets in the evening sky as 2016 opens. But Jupiter soon steps onto the evening stage. Jupiter is now in southern Leo, a spring constellation. So in the dead of winter, Jupiter and its lion host aren't going to rise until late at night.

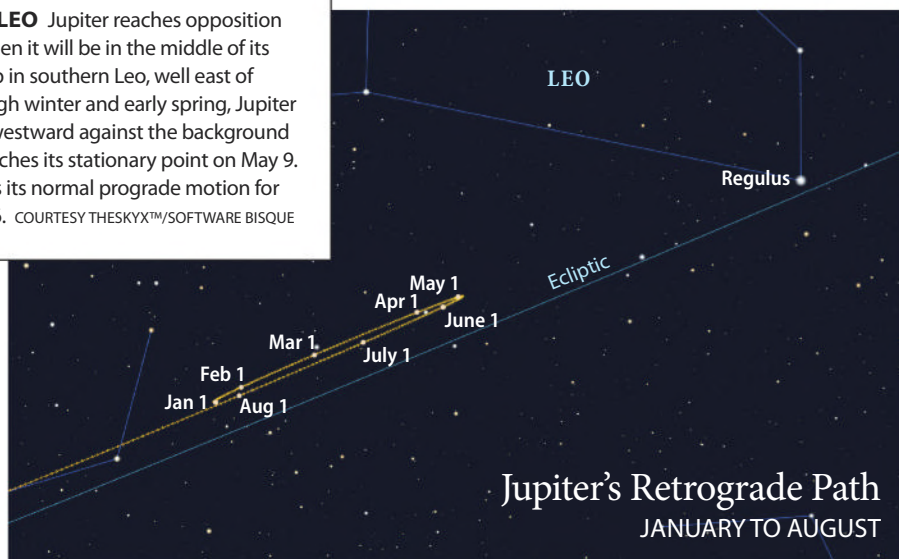
In early January, Jupiter doesn't rise until about 11 p.m., local time. That rise time moves up by approximately two hours a month, so by January 27, Jupiter is coming up in the east by 9 p.m. On that night, it is joined by the waning gibbous Moon.

The sky continues to advance, with winter constellations setting earlier in the west and spring constellations coming up earlier in the east. By February 23, when the now nearly full Moon shines next to Jupiter, the giant planet is rising in Leo about 7 p.m., putting it well and truly into our evening sky for convenient after-dinner viewing.

Jupiter rises right at sunset on March 8, when it reaches its annual opposition point. That's when the Sun, Earth and Jupiter lie along a straight line across the solar system. This geometry places us closest to Jupiter for 2016, with Jupiter then at its brightest.

Leading up to its March 8 opposition, Jupiter increases in brightness from magnitude -2.2 to -2.5 this winter, making it

LOOPING IN LEO Jupiter reaches opposition on March 8, when it will be in the middle of its retrograde loop in southern Leo, well east of Regulus. Through winter and early spring, Jupiter moves slowly westward against the background stars until it reaches its stationary point on May 9. It then resumes its normal prograde motion for the rest of 2016. COURTESY THESKYX™/SOFTWARE BISQUE



JUPITER'S MOONS

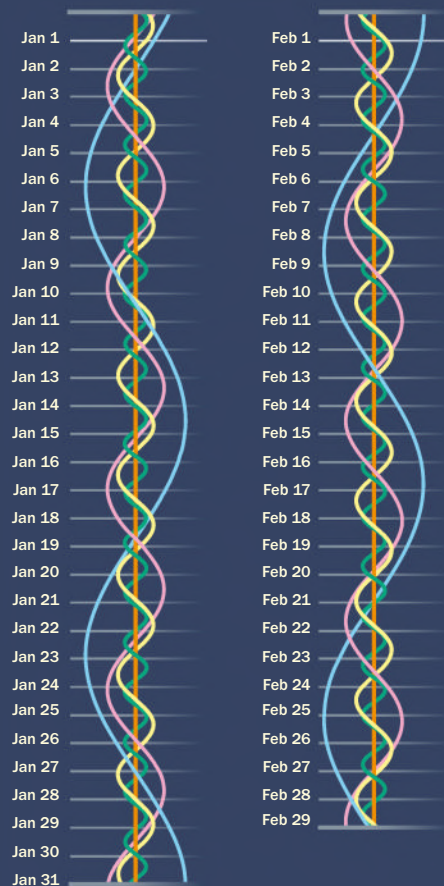
January and February 2016



The positions of Jupiter's four largest moons are shown for each night of the two-month period. Jupiter is represented by the central vertical shaft, while the moons are the four wavy lines. The horizontal lines mark 8 p.m., EST, on the dates indicated. Time flows from top to bottom, so look proportionately below the line for later times on a particular date. East is to the left, and north is at the top, as seen in binoculars. From closest to farthest, the moons are Io, Europa, Ganymede and Callisto. Orbital periods are 1.8, 3.6, 7.2 and 16.7 days, respectively.

KEY:

Io Europa Ganymede Callisto



second only to Venus for brilliance, its usual ranking. However, Jupiter appears even more obvious than usual now, as it shines in such a star-poor area of sky, making it look out of place and even artificial.

LEAP DAY!

What will you do with your extra day this year? As happens every four years, February

gets an added day in 2016, and the year has 366 days.

The intercalary day is added quadrennially following a rule originally devised by Julius Caesar, then revised and refined by Pope Gregory and his astronomical advisers in 1582. Years divisible by four are leap years, unless they are also century years (for example, 1700, 1800, 1900), in which

case they must be divisible by 400. So 2000 was a leap year. But 2100 will not be.

Why the intercalation intrigue? It's because, inconveniently, Earth does not take a whole number of days to orbit the Sun. A true year is 365.242 days long—almost, but not quite, one-quarter of a day longer than 365 days. (Just think how much simpler organizing civilization would have been if Earth orbited the Sun in exactly 360 days. Pharaohs, emperors, kings and popes

would have had little need for courts of astronomers!)

To keep our calendar in step with the seasons, we add one whole day every four years, instead of adding one-quarter of a day every year. To make up for the fact that the difference is not quite one-quarter of a day, leap days are dropped from three out of four century years.

This system ensures that the equinoxes and solstices occur on more or less the

same days every year, give or take a few hours. Because 2016 is a leap year, the equinoxes and solstices do arrive a little earlier than usual this year. For example, the spring equinox occurs at 04:30 Universal time on March 20, putting it late on March 19 for time zones in western North America. Enjoy your extra day, for which you can thank the revolution of Earth—and courts of employed astronomers in previous centuries. ♦

MOON HITS THE BULL'S-EYE From Vancouver and the West Coast, Aldebaran disappears behind the Moon in a bright twilight sky, but by the time the star reappears an hour later, the sky is dark. From elsewhere in Canada, both the ingress and the egress of Aldebaran happen in a dark evening or late-night sky. COURTESY THESKYX™/SOFTWARE BISQUE

OCCULTATION OF ALDEBARAN

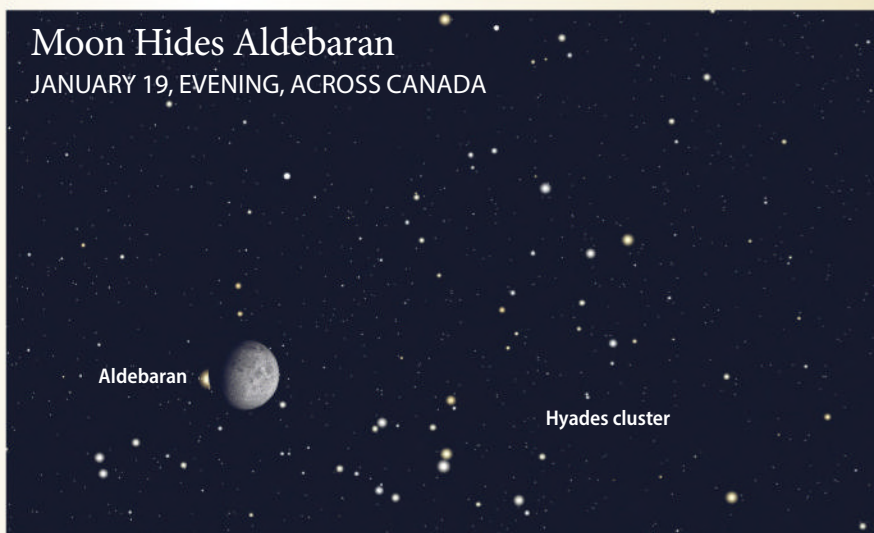
The Moon's shifting orbital path takes it into the Hyades star cluster and in front of the bright star Aldebaran almost every month this year, creating a series of occultations that will continue into 2018. After this, no other really bright star gets occulted until 2023. Indeed, Aldebaran is the brightest star the Moon can occult, with Antares, Regulus and Spica as the only other first-magnitude stars along the Moon's path. However, most Aldebaran occultations this year and to come are not visible from Canada, or they occur in daylight. But on the evening of January 19, observers all across Canada can see the waxing gibbous Moon pass in front of the "bull's-eye" star of Taurus. The 0.8-magnitude star winks out on the dark limb of the Moon but reappears on its bright limb, making its reappearance more difficult to catch.

MOON SHINES AMID THE HYADES

Roughly a month after the January 19 occultation, the waxing Moon is back amid the Hyades star cluster, on February 15, but appearing several degrees from Aldebaran, providing a fine scene for binoculars. The Moon does occult Aldebaran again but in an event visible only from Asia and the Pacific.

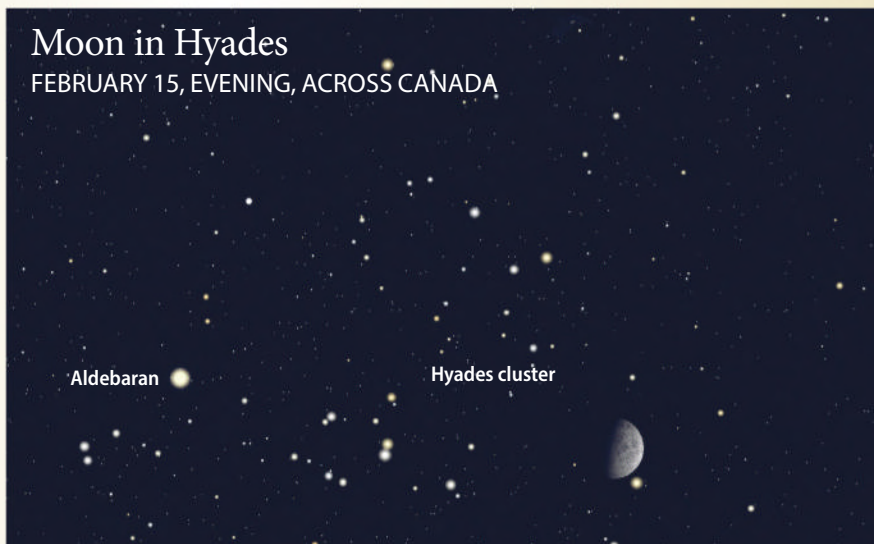
COURTESY THESKYX™/SOFTWARE BISQUE

Moon Hides Aldebaran JANUARY 19, EVENING, ACROSS CANADA



LOCATION	ALDEBARAN DISAPPEARS (INGRESS)	ALDEBARAN REAPPEARS (EGRESS)
HALIFAX	10:45 P.M., AST	11:58 P.M., AST
MONTREAL	9:28 P.M., EST	10:44 P.M., EST
TORONTO	9:18 P.M., EST	10:35 P.M., EST
WINNIPEG	7:51 P.M., CST	9:06 P.M., CST
EDMONTON	6:41 P.M., MST	7:41 P.M., MST
VANCOUVER	5:25 P.M., PST	6:26 P.M., PST

Moon in Hyades FEBRUARY 15, EVENING, ACROSS CANADA



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CATEGORY: Best deep-sky
digital high-resolution imagery

Prize: 8-inch f/5 photo-visual
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CATEGORY: Best tripod-mounted unguided photo

Prize: Ritchey-Chrétien 8" telescope



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CATEGORY:
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with digital SLR or
webcam-type imager
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IN OUR GALAXY AND BEYOND

Digital cameras record subtle colour and detail that human vision cannot detect in telescopic views of remote nebulae and galaxies

▼ **WITCH HEAD NEBULA** Yanick Bouchard of Mirabel, Quebec, acquired this image of the Witch Head Nebula in Eridanus while under dark skies near Rodeo, New Mexico. With a Celestron EdgeHD 925 in HyperStar f/2.3 mode, he used a stock Canon T3i for 28 images of 4 minutes' exposure at ISO 1600 for this digitally stacked photo. Also known as IC2118, the Witch Head Nebula is an interstellar cloud of fine dust grains illuminated by the nearby supergiant Rigel. Its bluish hue is caused partly by Rigel's colour and partly because dust grains in the nebula reflect blue light more efficiently than they do red.



▼ **SPIRAL GALAXY** Devoting 17.7 hours of exposure to record IC342, a large, dim galaxy in Camelopardalis, Daniel Borcard required three nights with his TEC 140mm f/7 refractor and SBIG ST-2000XM camera from his observatory in Saint-Roch-de-l'Achigan, Quebec.



▲ **ANDROMEDA GALAXY**
From Keswick, Ontario, Rob Bower needed to crank up the dew heaters on an unseasonably cool autumn night to keep the optics unfogged on his Explore Scientific ED 80mm apo refractor for this shot of the Milky Way's big neighbour galaxy M31, in Andromeda. A Canon 20D DSLR was used.

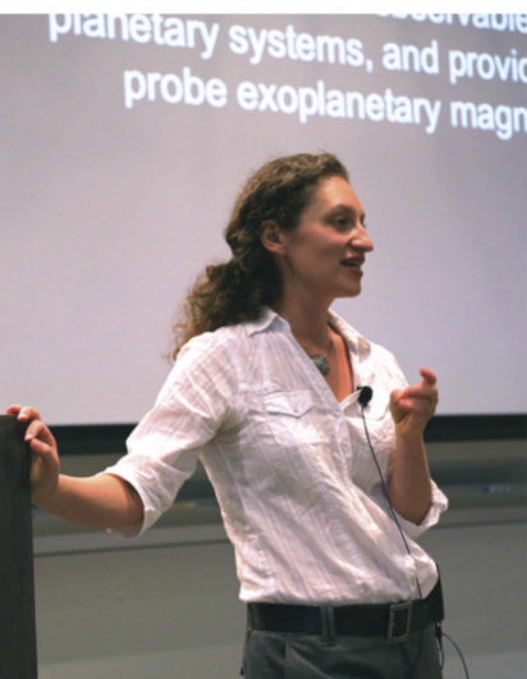


◀ **HEART NEBULA IN CASSIOPEIA** Also known as IC1805, the Heart Nebula is located in the Perseus Arm of our galaxy, at a distance of about 7,000 light-years. This image was taken by Luc Bellavance from Rimouski, Quebec, using a Canon T1i on a William Optics 80mm f/6.6 ED refractor at ISO 3200 with a Tele Vue field flattener. An Astronomik CLS-CCD Clip filter was used.

A Rising CANADIAN STAR

From a childhood interest in astronomy, a student embraces a career as a professional research astronomer using some of the world's largest telescopes

by Klaus Brasch



IN THESE DAYS OF “big science” and cutting-edge research, astronomy is increasingly becoming an international undertaking. It requires huge amounts of money and extraordinary innovation to build mega facilities like the planned Thirty Meter Telescope (TMT) on Mauna Kea, Hawaii, and the even larger 39-metre behemoth under construction at the European Southern Observatory in Chile. No single institution or nation can afford to go at it alone—nor has the necessary expertise—making multinational partnerships inevitable. Canada is a key player in the TMT project, just as it was 30 years ago with the still productive Canada-France-Hawaii Telescope (CFHT). For these and other reasons, many astronomers today are working collaboratively with colleagues across the world. Canadian Evgenya Shkolnik is a perfect example.

ASTRONOMER AT WORK Canadian Evgenya Shkolnik lectures on terrestrial (Earth-sized) planets of other stars and environments around red dwarf stars.

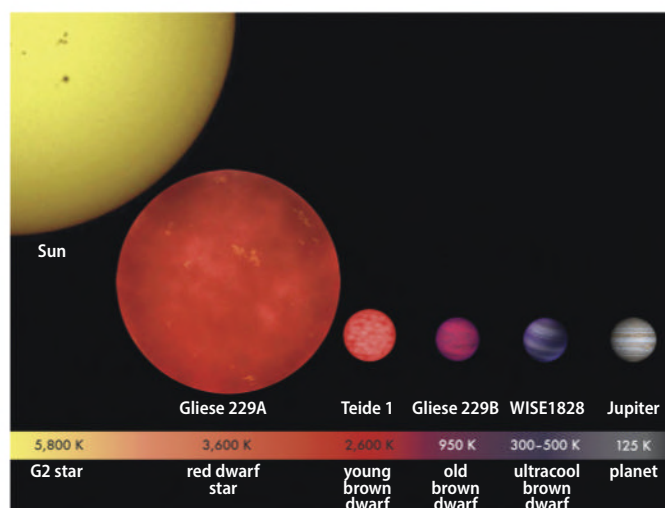
Born in Kiev, Ukraine, Shkolnik knew she wanted to be an astronomer since elementary school, while growing up in Dundas, Ontario. After graduating with a degree in math and physics from Dalhousie University, in Halifax, she was inspired by the confirmation in 1995 of the first exoplanet around a main-sequence star and continued to the University of British Columbia for graduate work with pioneering planet hunter Gordon Walker. She obtained her Ph.D. in 2004 and went on to postdoctoral research at the University of Hawaii at Manoa and the Carnegie Institution for Science, in Washington, D.C., before joining Lowell Observatory in Flagstaff, Arizona, in 2011. While doing all this, she and her husband are managing to raise three kids.

Shkolnik's research interests centre around extrasolar planetary systems, young stars and circumstellar discs. Using such telescopes as the CFHT, Keck (Mauna Kea) and Magellan (Las Campanas, Chile), she and her colleagues have investigated star-planet interactions, including the effects of tidal, magnetic and high-energy radiation on the formation and evolution of planets. She has focused her efforts on Sun-like G stars and M dwarfs, with the latter accounting for some 75 percent of the stellar population of the Milky Way and outnumbering Sun-like stars by about eight to one. To date, some 240 M dwarf stars have been discovered within a radius of 33 light-years of the Sun, and most interestingly, recent studies suggest that such stars have a propensity to form terrestrial planets.

Because M dwarfs are low luminosity, it should be easier to detect terrestrial planets within their rather constricted "habitable zones," between 10 and 40 percent of the Earth's distance from the Sun. The downside is that such planets might be perilously close to extreme ultraviolet radiation and strong tidal effects from the parent star during the system's early evolution. Consequently, any terrestrial planets near the parent star may not be well situated for life if their atmospheres are depleted of important molecules like water. On the other hand, if such planets have strong magnetic fields, then radiation extremes may be mitigated. Or if planets become tidally locked with one side facing their star, then intense cloud formation on that side may alleviate temperature extremes. Both these circumstances could render these planets more suitable for the emergence of life—or not. In addition, because of the sheer abundance of M dwarfs and their longevity (essentially lasting forever), chances are increased that many may host habitable terrestrial planets.

Upon joining Lowell Observatory, Shkolnik was working with the new state-of-the-art 4.3-metre Discovery Channel Telescope and its next-generation spectrometer to investigate the age of M dwarfs and the first indications of planetary formation, atmospheric composition and interactions between stellar and planetary components. Those ambitions and qualifications have earned her a position at Arizona State University in Phoenix, one of the largest universities in the United States, although she will also maintain her affiliation with Lowell Observatory. ♦

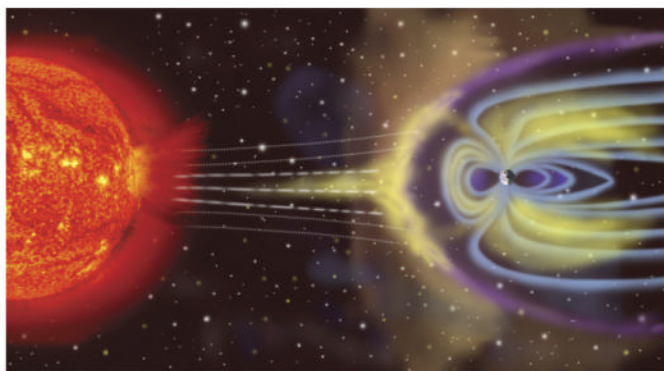
A regular contributor to SkyNews, Klaus Brasch is a retired Canadian biology professor with a lifelong interest in astronomy. On many clear evenings, he can be found in his well-equipped backyard observatory in Flagstaff, Arizona.



QUEST FOR POTENTIALLY HABITABLE PLANETS Small rocky planets roughly the size of Earth have been detected orbiting stars similar to the Sun as well as smaller, cooler stars known as red dwarfs. COURTESY NASA



VIEW FROM THE TOP Using large telescopes such as Lowell Observatory's 4.3-metre Discovery Channel Telescope in Arizona, Evgenya Shkolnik has studied red dwarfs, which outnumber Sun-like stars in our galaxy by a ratio of eight to one, making them ideal targets for research astronomers. COURTESY LOWELL OBSERVATORY



MAGNETIC ATTRACTION One aspect of Evgenya Shkolnik's studies is characterizing the environments surrounding rocky planets with strong magnetic fields in orbit around red dwarf stars. COURTESY NASA



PLANNING A HIKE ON MARS

A southward-looking panorama from NASA's Curiosity Mars rover shows diverse geological textures on Mount Sharp. Three years after landing on Mars, the mission is investigating this layered mountain for evidence about changes in the Martian surface environment, from an ancient time when conditions were favourable for microbial life to the much drier present. Gravel and sand ripples fill the foreground, typical of the terrains that Curiosity traversed to reach Mount Sharp from its landing site. Outcrops in the midfield are of two types: dust-covered, smooth bedrock that forms the base of the mountain and sandstone ridges that shed boulders as they erode. Rounded buttes in the distance contain sulphate minerals, perhaps indicating a change in the availability of water when they formed. COURTESY NASA



Old Man on His Back Ranch

How an astro-club road trip created Canada's newest dark sky park



BIG SKY The Milky Way and an aurora decorate this wide-angle view. PHOTO BY ALAN DYER

THERE'S SOMETHING about a blue sky over a golden carpet of sunlit grass that fills my heart. The anticipation of the heavens sure to soar over such a place at night brings out the kid in me, and finding new spots like this recreates the magic of discovering an untouched view of the Milky Way all over again.

Back in the summer of 2013, The Royal Astronomical Society of Canada (RASC) national observing chair and then RASC Regina Centre president Chris Beckett invited me to the prairies on an ambitious four-night speaking tour that spanned Saskatchewan's capital, every dark sky preserve in the province and a little-known stargazing region near the town of Eastend (ironically, on the southwestern border near Montana and Alberta), population 530.

After a talk to a school group and a lunch hosted by the town's mayor, Chris, myself and a group of enthusiastic amateur astronomers visited Eastend's Wilkinson Memorial Observatory.

As we checked out the domed building's brand-new 11-inch Celestron telescope, Chris and I struck up a conversation with

South Saskatchewan-based Nature Conservancy of Canada (NCC) interpreter Sue Dumontel, who had joined us for part of the tour, interested in the notion of conserving not only land but the skies above.

In the months that followed, Chris stayed in contact with the NCC, which decided that it wanted to pursue an RASC dark sky designation for some of the land its private not-for-profit organization manages across Canada. Two years after our visit, the NCC's Eastend-area Old Man on His Back Ranch (OMB) was declared one of the first RASC nocturnal preserves.

Unlike the RASC's more numerous dark sky preserves, a nocturnal preserve is an area in which artificial lighting is strictly controlled but astronomical access is not a prerequisite.

CANADA'S MOST PERFECT OBSERVING SPOT?

While OMB was established to protect the remaining intact native grasslands, the NCC isn't averse to visits from those looking to enjoy unspoiled views of the universe.

"OMB has always attracted nature and hiking enthusiasts and those curious about the plains bison roaming through here," says Natalie Nikiforuk, the NCC's natural area manager for southwestern Saskatchewan. "This designation adds another dimension to ranch visitors' experiences. We anticipate that a host of astronomers, novice and otherwise, will visit the ranch to view its rich night skies."

After a few observing sessions in the area, Chris says the potential of this semiarid grassland plateau rivals or surpasses that of any other sites he's visited in Canada. "It's as if it were designed for astronomy."

Normally, you might see farm lights or a town 80 to 100 kilometres away, even in a place this remote. But here, a shallow 15-kilometre-wide bowl at the top of the plateau blocks out the last remains of light pollution while still providing down-to-the-horizon views all around.

"Out here, the Milky Way gets to be all over the sky," says Chris, noting that when the sky is this dark, the stars seem to grow similar in brightness. "They just start to appear on top of one another."

WHERE TO STAY: AT THE RANCH AND IN TOWN

OMB is located 60 kilometres southwest of the town of Eastend (200 kilometres from Swift Current), and camping is permitted here with advance arrangements through the NCC. A new visitor centre consists of a modular home with a public washroom. It's a great place to drop by for a cup of tea and a visit with volunteer staff.

After spending an evening under the stars on this 5,316-hectare ranch, check out the local flora and fauna by day. In addition to bison, other critters that have been spotted here include the swift fox, Sprague's pipit, burrowing owls and herds of pronghorn antelope. You might also come across some of the numerous teepee rings on the property.

Don't want to camp? Rooms at several motels and B&Bs in nearby Eastend can be reserved for a comfy sleep after a night of observing at the ranch.

Eastend is also your best bet for food and drink. While in town, be sure to try the Greek pizza or the Greek lamb (a specialty) at Jack's Cafe while enjoying the lively murals that cover the walls of the dining room. Also tasty in town are the breakfasts and all-day baked goods at SON OTO Cafe and the summer eats and soft ice cream at Charlie's Lunch.

'IS THAT A DINOSAUR NEXT TO YOUR OBSERVATORY?'

By far, the coolest daytime tourist attraction in the area is Eastend's T.rex Discovery Centre, a state-of-the-art museum famed for its centre piece, "Scotty." In 1991, Scotty's 66-million-year-old fossilized skeleton became the first T. rex found in Saskatchewan and one of only 12 known in the world at the time. In addition, Scotty was one of the largest and most complete T. rex skeletons.

The T.rex Discovery Centre also boasts a separate exhibit featuring animals that roamed Saskatchewan after the Age of Dinosaurs. Temporary displays showcase everything from present-day wildlife to a large meteor that crashed in the area. It's just another aspect of a place that lets you travel through both space and time—a time when the entire Earth offered up starry

skies and every night seemed like a trip through the cosmos.

As galactic views yield to blue-skied vistas of tall grass and prairie flowers, the rising Sun here beckons you to stay just one more night to enjoy more of what could well be Canada's most perfect stargazing site. ♦

Peter McMahon is the new manager of The Jasper Planetarium, as well as the owner and manager of The Ontario Planetarium. For more information on getting to and staying at Old Man on His Back or to explore it virtually through Google Street View, check out www.wildernessastronomy.com and click on the "Magazine" link.

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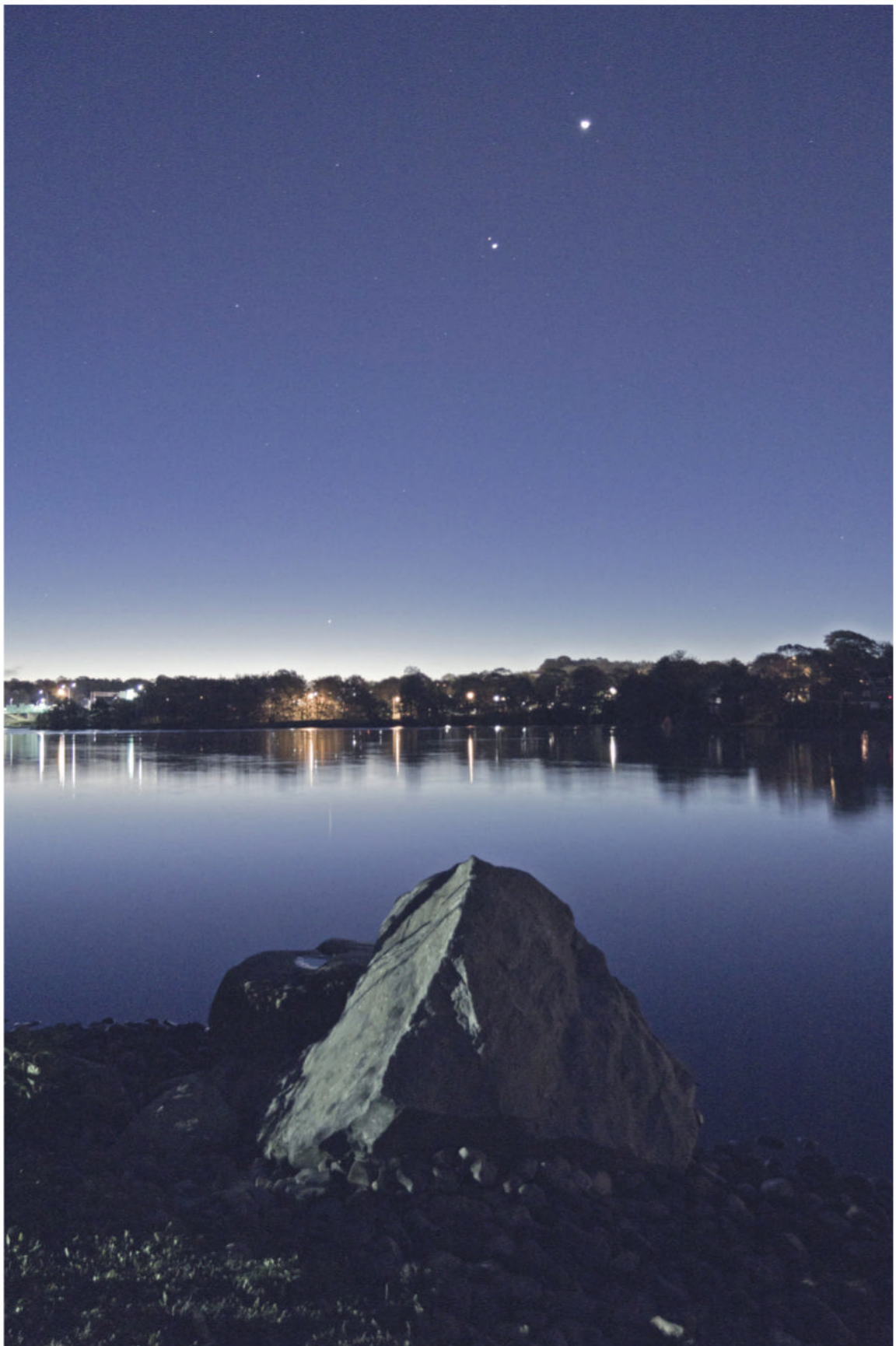
Wide-angle lenses are an essential tool for astrophotographers seeking to capture auroras, bright planet conjunctions, solar and lunar halos and other targets in our corner of the solar system



▲ **EXCEPTIONAL AURORAL STRUCTURE** From southwest of Didsbury, Alberta, Paul de Rosenroll captured this impressive aurora on August 22, 2015, using a spectrum-modified Canon 6D at ISO 1600 with a 16mm lens at f/3.5 for a 6-second exposure. "I grew up in Edmonton and have seen many dancing northern lights before," he says, "but none this active for so long and never this far south. The group at All-Star Telescope in Didsbury suggested I send my photo to *SkyNews*."

◀ **THE COMPLETE PACKAGE** Mary Brown of Osgoode Township, near Ottawa, reports: "On October 2, 2015, we were treated to a lovely 22-degree solar halo with sun dogs, an upper tangent arc, a parhelic circle and a Parry arc—all captured with an 18mm lens on a Canon T3i. A 22-degree solar halo can often be seen when there are thin, wispy, cirrus clouds. The parhelic circle was faint in some places but complete. I had not seen a complete one before, so this was exciting. Starting at the Sun, a white band—the parhelic circle—passed through the sun dogs and extended beyond them in the direction away from the Sun."

► **FOUR PLANETS AT DAWN** This tranquil early-morning scene was taken on October 17, 2015, by the shore of Lake Banook in Dartmouth, Nova Scotia, by veteran amateur astronomer Dave Chapman. From top to bottom, the planets are Venus, Mars, Jupiter and Mercury (near the horizon). Of course, a fifth planet, Earth, is in the foreground. Chapman used a Canon Digital Rebel SL1 at ISO 800 with a 17-85mm lens at 17mm and f/4 to take the 4-second exposure.





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CANIS MAJOR

Orion's faithful hound plays near the snowy south horizon. Sirius, the heaven's most brilliant stellar gem, marks its glistening snout.

by Ken Hewitt-White



CANIS MAJOR never gets far above the treetops, but its five brightest stars are easy to identify. West of Sirius (alpha Canis Majoris), which shines at magnitude -1.4 , is 2.0-magnitude Mirzam (beta Canis Majoris). A dozen degrees south of Sirius is a triangle of stars featuring Adhara (epsilon), magnitude 1.5; Wezen (delta), magnitude 1.8; and Aludra (eta), magnitude 2.4. It's an impressive cast, with Sirius stealing the show.

Five thousand years ago, Sirius was Sothis, the celebrated "Nile Star," whose rising near dawn in late June heralded the annual life-giving flood. Because of this association with the Nile River, the Egyptians regarded Sirius as the most important star in the sky. Later in Egyptian history, Sirius was the jackal-headed Anubis, lord of funeral rites and protector of tombs.

Greek lore wove similar threads of association. With apologies to Orion, Canis Major moonlighted as the horrible Cerberus, a three-headed, snake-ridden whelp assigned to guard duty at the gates of Hades. Sirius became the "Scorching One," reflecting a belief that the blazing lucida added heat to the Sun when it appeared in the same direction in the daytime sky. Later, Virgil reviled Sirius: "...that burning constellation, when he brings drought and diseases on sickly mortals, rises and saddens the sky with inauspicious light."

Sirius's association with hot, sultry summer days led to the term "dog days of summer" (named, of course, for Sirius, the Dog Star, which marks Canis Major's nose). The dog-days expression is one of the rare elements of ancient sky mythology that is still in common usage in the 21st century.

In China, nervous farmers didn't enjoy a bright star so low to the ground. Eyeing its wavering light with suspicion, they envisioned Sirius as *T'ien lang*, a troublesome jackal or wolf that hid among crops and raided farmyards.

Sirius fares better in a story by 19th-century Finnish poet Topelius. His tale faintly echoes the Chinese legend about separated lovers who leap across the Milky Way in joyous reunion. Topelius imagined his lovers actually constructing the Milky Way to bridge the deep waters that kept them apart. In refreshing contrast to Virgil's rant, Topelius reports that the ecstatic couple: "Straight rushed into each other's arms, And melted into one; So they became the brightest star... Great Sirius, the mighty sun." ♦

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SEE PAGE 37 FOR PRIZE DESCRIPTIONS.

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SkyNews is not responsible for loss of or damage to materials submitted. Mailed photos will be retained on file unless accompanied by a self-addressed envelope with sufficient postage.

This contest is open to residents of Canada only.

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Lunar Layers of Time

Unravelling the Moon's geologic history involves a lot of ingenious detective work and a small handful of solid evidence

Geologists can tell us a great deal about things that happened recently. They can even tell us a fair amount about what happened millions of years ago. But, generally, the further back in time they look, the less they know with certainty. And here's the problem with understanding the history of the Moon: Just about everything happened a long, long time ago. The Moon that drifts through our night sky is essentially the same one our distant humanoid ancestors gazed up at. It is the same Moon that lit the nighttime landscape of the dinosaurs. In fact, if you could go back in time three billion years, you would have no trouble identifying most of its main features. The changes that have occurred in the past couple of billion years have mostly been the finishing touches—the addition of a new crater here and there, and that's about it.

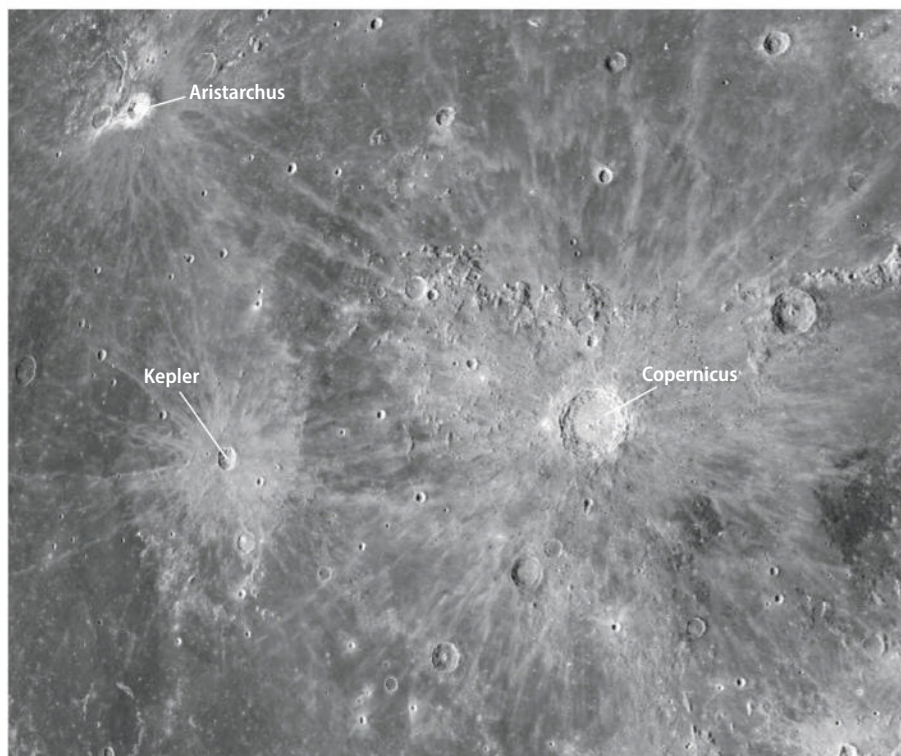
But (and this is an important “but”) the Moon's unchanging surface is also what makes it so important to study. By examining the lunar surface, scientists effectively look back in time and see what was going on in the early days of the solar system. On Earth, the geologic record of the distant past is all but gone, having been thoroughly erased by plate tectonics and erosion by wind and water. To discover what the early solar system was like, we need to look skyward and study the Moon.

As they did for the geologic history of Earth, scientists have divided up the Moon's past into several major periods, each marked by important events. They use an approach known as stratigraphy. It's a powerful tool that allows lunar geologists to construct a detailed sequence of events. Together with a handful of specific dates gleaned from analyzing Moon rocks returned by various space missions, they have pieced together a broad outline of the Moon's history.

The most ancient lunar features date back to the pre-Nectarian period, which spans the formation of the Moon until about 3.92 billion years ago. This was a time of heavy bombardment, as millions



PHOTO BY GARY SERONIK



DAWN OF A NEW ERA The impressive ray crater Copernicus, along with nearby Kepler and Aristarchus, formed in the current lunar epoch known as the Copernican period, which began 1.1 billion years ago. All three craters are rewarding telescopic sights. COURTESY LRO/NASA

of asteroids, comets and meteorites collided with our nearest neighbour in space, each producing an impact crater. Some of these earliest craters still remain, though they are battered and bruised from later collisions.

The formation of the Nectaris Basin marks the beginning of the Nectarian period, which lasted until about 3.85 billion years ago. During this time, the cratering rate slowed down, possibly as the number of impacters diminished. Still, by one estimate, 1,700 craters larger than 32 miles in diameter formed during this relatively brief period.

One of the biggest events in lunar history happened 3.85 billion years ago: the collision that formed the Imbrium Basin. This event marks the end of the Nectarian period and the beginning of the Imbrium period. Most of the maria formed late in this era, which lasted until about 3.2 billion years ago. At this point in the Moon's history, the majority of the big craters and maria that we see today were in place.

The Eratosthenian period that followed was the longest, lasting until 1.1 billion years ago. A few more craters were added, and the last lunar volcanism occurred as magma oozed to the surface to fill in a few craters and low spots.

Today, the Moon is in the Copernican period, which began 1.1 billion years ago. But by way of noting how things have slowed down, only 44 craters larger than about 50 miles in diameter have formed in this latest span of lunar history, which averages out to one every 25 million years. Slow going, indeed! That said, among those 44 recent craters are some of the most impressive on the surface of the Moon, including the great rayed crater Copernicus, which formed roughly 800 million years ago. Other Copernican period craters include Proclus, Aristarchus, Kepler and, most notably, Tycho. ♦

An award-winning author, Gary Seronik is the editor of Antonín Růkl's classic Atlas of the Moon and Charles A Wood's The Modern Moon. He is also editor of this magazine's website, SkyNews.ca.

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A Touch of Frost

Ken invokes a favourite poetic verse as part of his celestial season's greeting

HERE I LIVE in the B.C. burg of Chilliwack, not far from our Pacific coast, the weather in late December is likely to be mild, cloudy and very wet. Sometimes, though, the winter air turns cold and clear and the night sky fills with stars. I'm hoping for starlight this December 31 so that I can indulge in one of my favourite, albeit rare, holiday rituals: stargazing on New Year's Eve. Picture me outside in my yard as darkness falls on First Night...

Hmmm. There's no Moon or naked-eye planets this evening. Fine; bring on the star-stuff. But I can't even see the Big Dipper. The famous asterism is tangled in the treetops near the north horizon. For a better view, I peer northward in the alley behind my house. From that vantage point, I'm amused to see the Dipper's bowl seemingly balanced atop a neighbour's peaked roof. Even more strangely, the Big Dipper looks *really* big. Just as a rising full Moon appears unnaturally large, the low-lying Dipper seems twice its normal size.

Facing west, I notice the lingering bright stars of the Summer Triangle (it should be called the Four Seasons Triangle), with the Northern Cross standing impressively upright. To the south are dimmer constellations I can't trace in my suburban sky. A good one, though, is Cetus the whale. In my mind's eye, I see the immense cetacean basking in cold celestial waters. Northwest of Cetus is the Great Square of Pegasus, part of the upside-down flying horse (my imagination has a harder time with that one), while stretching northeast of the Great Square is the slender form of Andromeda. And almost directly overhead, at the threshold of my vision, is a teensy, faint cloud. It's the Andromeda Galaxy, a mere 2.6 million light-years away.

From Andromeda, I cast my gaze eastward toward Taurus the bull, highlighted by the glittering Pleiades and V-shaped Hyades clusters. Below all that is Mr. Glitter him-



Orion rising. PHOTO BY ALAN DYER

self—Orion the hunter. The brilliant stars Rigel and Betelgeuse are madly twinkling kaleidoscopic gems; the tri-starred belt of Orion points nearly straight up. And like the low-down Dipper, the hunter's rectangular torso looks extra-expansive rising sideways. As Orion climbs over the rugged Coast Mountains east of my house, I recall some lines penned in 1923 by the beloved American poet Robert Frost in his delightful poem "The Star-Splitter":

*You know Orion always comes up
sideways.
Throwing a leg up over our fence of
mountains,
And rising on his hands, he looks in
on me*

And I look in on him too. Indeed, another of my stargazing rituals is noting when the big guy reappears before dawn each fall. For me, observing Orion again after his long summer vacation is as seasonally significant as sighting the first robin of spring. But in Frost's insightful verse, Orion is merely a

springboard to a deeper take on the universe. We arrive at the serious stuff via a circuitous and whimsical tale about a hapless farmer named Bradford McLaughlin, who is so taken by the starry firmament and so lousy at farming that:

*He burned his house down for the
fire insurance
And spent the proceeds on a telescope
To satisfy a lifelong curiosity
About our place among the
infinities.*

I wouldn't torch my house to finance a telescope (man, oh, man, that would be some instrument!), but I do share Brad's affinity for infinities. The only way I've been able to truly satisfy my own lifelong curiosity about the heavens is by having at least one "star-splitter" aimed upward every clear night—preferably with a like-minded companion:

*Bradford and I had out the telescope.
We spread our two legs as it spread its
three,
Pointed our thoughts the way we
pointed it,
And standing at our leisure till the day
broke,
Said some of the best things we ever said.*

That last touch of Frost warms my whole being. Even so, New Year's Eve will be too cold for this old stargazer to last much beyond the midnight fireworks. And I won't have a real-life Brad for company (subzero stargazing hasn't many advocates). But I'll be just fine provided Orion looks in on me. He always does. ♦

Contributing editor Ken Hewitt-White observes the night sky from the mountains of British Columbia.



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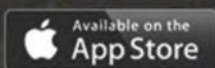
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